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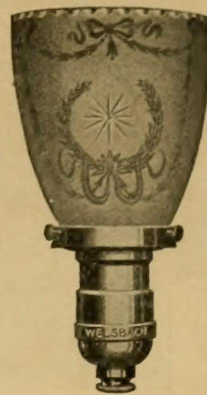
Merely the Welsbach No. 82 Socket Burner equipped with fancy glassware.



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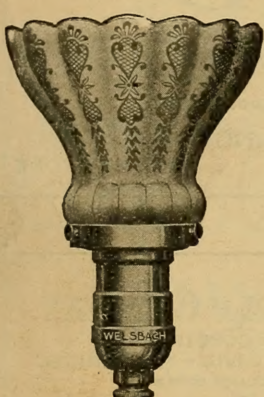

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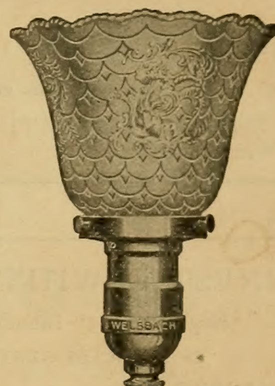

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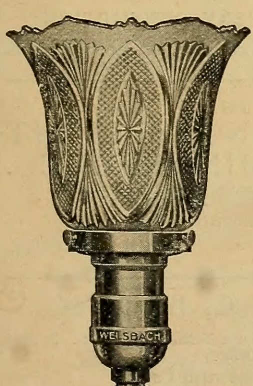

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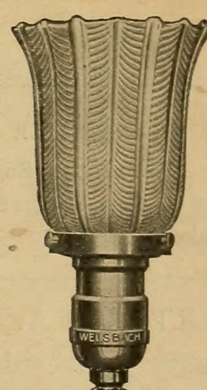

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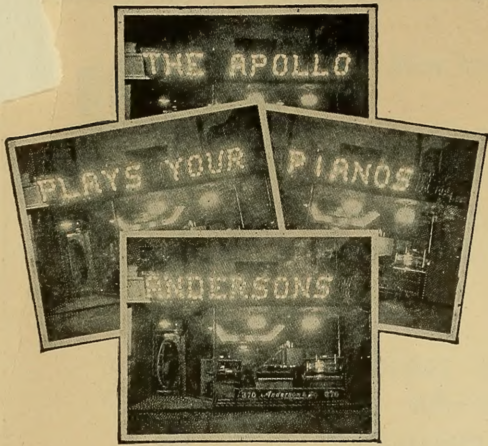

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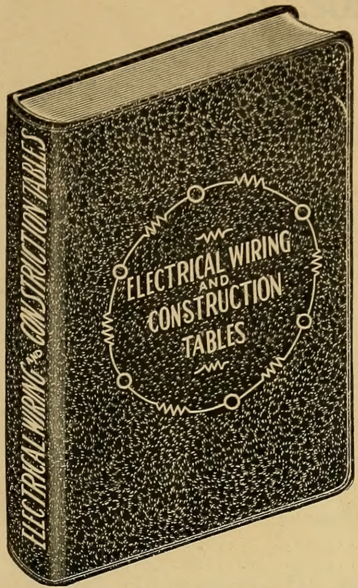

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THE ILLUMINATING ENGINEER

Vol. II. MARCH, 1907 No. 1.

Plain Talks on Illuminating Engineering

BY E. L. ELLIOTT.

WITH THE CONSUMER

We have thus far discussed various subjects pertaining to illumination from the engineering standpoint, having in view more particularly the interests of those who are seeking technical information on this new branch of science. In this issue we will vary the theme and have a brief talk directly with the user of light.

Sight is the most precious of the senses, and yet it is one which is probably more frequently abused than any other. It is strained and overworked until nature gives warning in the shape of pain or defective vision; and then we fully realize what a calamity it is to have this sense impaired. Unfortunately in many cases the warning comes too late to enable us to restore fully the original and normal condition. A proper regard for the welfare of the eyes would seem to be only a matter of the most obvious common sense; but like many other obvious precautions, it is overlooked until the protest is made by nature.

In modern civilization artificial light is something which every individual uses every day to a greater or less extent; and as the use of light involves the use or abuse of the eyes, the importance of an intelligent understanding of so utilizing light that the eyes will be decently used, and not abused, is at once apparent. Bad lighting is exceedingly common, so common in fact that, except in aggravated cases, it does not even bring forth a serious protest, unless occasionally when the bills appear to be excessive. It is one of the idiosyncracies of human nature that a gas or electric light bill which is a dollar or two more than it ought to be, will bring on a veritable "brainstorm," while a lamp or illuminating device which outrages the precious organs of vision every moment of its use, is accepted without the slighest protest, and in fact, often with real, if unexpressed, congratulations upon its "prettiness."

Now, it is a general truth, that the

right way to do a thing is the *cheapest* way also; and it will be a comfort for the consumer to learn that he can treat his eyes with decent respect and his pocketbook with equal respect at the same time. Bad lighting is in almost every case expensive lighting also, not from the merely theoretical point that anything bad is really expensive at any cost, but in the actual dollars-and-cents amount of its cost.

The old-fashioned open fire-place was a bad way of heating a room; it created drafts which were positively dangerous to health, and toasted your face while your back was freezing. As might be expected, the method was also uneconomical to the highest degree; the single virtue which it possessed was that it looked pretty. The average methods of lighting still in use may be fairly compared to this now obsolete method of heating. In many cases—probably the majority—a large amount of light is wasted by being scattered about where it is not at all needed and is often positively objectionable, much as the old fire-place used to send 90% of its heat up the chimney.

Scientists and manufacturers tell us that there have been wonderful improvements made in the production of light within the last twenty-five years; and so there have—from their point of view. Much more powerful lights have been produced, more convenient means are at hand of distributing and supplying the energy which produces the light, and the actual cost of these particular forms of light has been gradually reduced. But *producing light* is one thing, and getting good *illumination* is quite another. So far as illumination is concerned, that is, the use of light for making objects visible, the most skilful illuminating engineer, utilizing the latest improvements, can produce no better results for the most common uses of illumination, such as reading, writing, and the ordinary work of the household, than could be produced if gas and electricity were unknown quantities. So far as actual illumination is concerned, even the candle of our grandfathers is capable of producing results far better than are often produced at the present time with the most improved electric or gas lamps; and the illumination from a good kerosene oil lamp has not yet been surpassed for the purposes mentioned by any illuminant known to science. Admitting the truth of all this, however, does not imply an impossibility to secure equally good illumination with modern illuminants, in addition to many and great advantages by way of convenience, cheapness, and appearance. The fact is simply this: good illumination can be produced with the old illuminants; equally good illumination can be produced with the new illuminants when properly used, but with careless or improper use a very inferior illumination may result.

The older forms of illuminant were far less liable to abuse than the newer forms. It is just this possibility of serious abuse of the many newer forms of illuminants, as well as the greater variety of effects, greater convenience, and greater economies possible with the newer, that has called forth the specialist in the subject of lighting, and established illuminating engineering as a distinct branch of science. While the services of such specialists may be profitably employed in large installations, and in many cases in the smaller ones as well, there are many simple points which the average consumer can observe and engineer for himself. This is especially true of the ordinary dwelling house, and it is to this, therefore, that we will direct our attention.

The several different illuminants used for domestic lighting are candles, kerosene lamps, gas flames, mantle gas burners and electric lamps. The candle has not become obsolete by any manner of means; it still holds an important place in domestic lighting on account of its portability, and the decorative features possible with it, the latter being much enhanced by the sentiments and associations which cling to this "light of our fathers." On account of its portability the candle is often used as a light to carry about for temporary use into dark closets, infrequently used rooms, etc. It has one serious objection for this purpose which is overlooked to a greater extent than it should be, and that is the danger from setting fire to draperies or clothing. There are exceedingly convenient little electric candles, operated by small batteries which can be easily purchased and replaced, that are in every way more convenient and absolutely free from this danger, and which should, therefore, entirely displace the candle for such use. For special decorative features, as for dining tables, the candle will long hold its place; in fact, so well recognized is this use that it is very largely imitated by both gas and electric devices; though, as in other cases an imitation, they never produce quite the effect of the "real thing."

Kerosene lamps are, generally speaking, well used; and, barring the care necessary to keep them in order, are very satisfactory lights for reading, writing, and sewing. The lamp is commonly placed on a table and provided with a shade which hides the flame and gives the proper light on the work.

Gas flames are still frequently used, notwithstanding the mantle burner gives a very much larger amount of light for a given amount of gas. The ordinary gas tip is always ready to light, while the mantle burner may not be; and where a light is only occasionally required, the gas flame is the better form to use. As simple as it is, the form of the gas tip is a matter well worth attention. Some gas tips give a flickering, irregular flame, which will break up glassware nearly as fast as it is put on; and although this fact is not so apparent, it is wasteful of gas as well. The ordinary Lava tip, having a plain slot through the center, is ordinarily of this character, and should be discarded on general principles. Aluminum tips have come into the market to a considerable extent; but while these give a large, steady flame, they are highly wasteful of gas and should therefore be avoided. The best forms are those which have two small round holes in the top and are fastened into the short piece of brass tube or "pillar" which screws onto the gas fixture. The Bray tip is one of this kind, which is made in England; but there are others on the same principle and equally good, produced in this country. Your plumber may not be familiar with this kind of burner tip; but if he is not, your gas company will gladly supply you at a trifling expense. In many cases a tip burning but one foot of gas per hour will answer every purpose, and the three-foot tip will serve where more light is required.

Where light is required regularly however, the mantle burner should always be used. These can be had in a great variety of forms, and in prices varying from ten cents to two dollars. The 10-cent burner is capable of giving nearly as good results as the average burner that is much more expensive, *provided it is properly adjusted* to get the right flow of gas and air; but unless you are capable of making this adjustment yourself, it will be better

to purchase the more expensive burners, which the dealer will either put up and adjust, or which have adjusting devices that are so simple as to require no more skill than turning an ordinary kerosene lamp up or down. For house use, the smaller burners should be selected. On tests which we recently had conducted with various sorts of chimneys, it was found that the short straight chimney gave the greatest amount of light for a given amount of gas. These little chimneys can be had at any good supply store, made of an exceedingly thin and tough glass, which will stand almost any amount of heating and cooling without breaking or discoloring. If the small chimney is used, it should always be of this quality of glass. Mica chimneys soon discolor and become more or less opaque. A combined chimney and globe, that is, a chimney of an oval form with holes around near the bottom, is also much used; it is ordinarily made of opalescent glass, and, while not quite so efficient as the little straight chimney, it is handsomer and gives very good results, and is perhaps the best selection for ordinary use, as it requires no diffusing globe outside of it. Mantles also vary greatly in price and quality. While the 10-cent mantles will give very good results for a time, on the whole it is better to buy those that are somewhat more expensive. All mantles deteriorate by use, and, if not broken before, should be thrown away when they have run down in brightness.

Within the past year or two an inverted form of mantle burner has been put upon the market and very largely advertised. The principal advantage claimed is that more of the light is thrown down, where it is more useful. This advantage is more fanciful than real, for it is a very simple matter, by the use of a suitable reector, to throw the light of the ordinary upright burner either below, or in any other direction where it is wanted. The inverted burner does not work well on low gas pressures, and before purchasing them it would be well to find out whether the pressure commonly supplied is high enough to operate them successfully. The gas company will probably give you honest advice on this point if asked.

Mantle burners are often used on table lamps; for this purpose they should of course be provided with a shade which will shield the eyes from the direct light of the mantle. All mantle burners give out a large amount of heat, and this is somewhat objectionable in the case of a table lamp, as radiated heat is very trying to the eyes. It is often better to place a burner, provided with a reflector which will throw the light down, on a chandelier, taking care to sit so that the light will fall over the shoulder when reading.

If you think that your gas bills are too high, remember that the ordinary Lava tip, and the metal tip, are very wasteful of gas.

The ordinary tip burns five or six feet per hour, and in many cases a one-foot tip will give all the light necessary.

A mantle burner will give four times as much light for a given amount of gas as the ordinary flame.

Decorative shades absorb from 25% to 75% of the light.

Electric lamps, being capable of such a great variety of uses, afford a proportionately greater opportunity for bad effects. We can take up here only some of the more frequent troubles and faults and show how they may be avoided. Let us first consider the reading lamp. So common are bad effects obtained with electric lamps for this purpose that there is quite a

widespread belief that the electric lamp in itself is not well suited for reading purposes. This is an absolute mistake. The light itself from an electric lamp is as capable of giving good reading illumination as the light from the best kerosene lamp; although it is not uncommon, even where electricity is used for general lighting, to find a kerosene lamp used for reading purposes. An electric lamp gives all of its light from the fine carbon thread or "filament," within the bulb. This filament is, therefore, intensely brilliant—vastly more so than a gas or lamp flame; and such a lamp should never, under any circumstances, be so placed that the filament can be seen when reading. Even though the eye does not look directly at it, the effect may be equally harmful, since the eyelid is semi-transparent and not a safe protection against this very high intensity. In the second place, the light direct from a bare electric lamp is not even; if you place a sheet of paper near such a lamp, you will see that the paper is not evenly illuminated, but covered with various streaks of light and shade. Such illumination on a paper or book is bad for the eyes, as the eye, in running along over the sheet, sees first light and then dark, which produces the same effect as light that flickers. The electric reading or table lamp as commonly offered for sale is primarily a piece of bric-a-brac, gotten up entirely from the decorative point of view, and without any regard for the practical use to which it is to be put. It is very frequently provided with some sort of a fancy stained glass shade, or has a silk umbrella over it, all intended to catch the eye of the purchaser when making his selection *by daylight*. The shape of the shade may be such as to reduce the light to such a small circle underneath the lamp as to necessitate putting a book or paper almost under it in order to see; or it may be so extended, and the lamp so placed that the filament shines directly into the eyes. In practically no case is any provision made for diffusing or softening the light, so as to prevent the streaks of light and shade which we have just mentioned; and lastly, no reflector is used excepting the slight reflection which may take place from the glass or silk, and as a result two or three times as many lamps have to be used as is necessary. Unfortunately it is quite troublesome to remedy these very serious defects in the class of table lamps described.

A single electric lamp of the ordinary size, 16 candle-power, will furnish sufficient illumination for three or four persons, if it is properly used. An inexpensive, but very pretty and efficient table reading lamp may be gotten up by selecting a plain standard that is rather high, say 18 inches; have a holder put on this which will support a straight-side prismatic glass reflector about 10 inches in diameter; see that the electric lamp projects well up into this reflector; over this glass reflector place a shade of silk or tissue paper of a green tint; extend this so that when the lamp is in the ordinary position the filament cannot be seen. The prismatic reflector lets a little light through, which will give a pretty glow to the paper or silk shade, and at the same time throws the light down where it is wanted for reading, and also practically does away with the light and dark streaks. A plain porcelain reflector, white on the inside and green on the outside, will give about equally good illumination, but is not so decorative.

Never in any case sit with the light directly in front of you, as you are sure to get a reflection which produces a blur on the paper.

It is very common to find in apartments and houses of the present day a chandelier having an "art glass" shade in the center intended for lighting either a dining room or library table. Within this shade there is usually a cluster of from two to six electric lamps; and in order to secure a satisfactory light on the table, it is usually necessary to use at least two, and often four of the lamps. Again a single 16 candle-power lamp will furnish all the light necessary if properly used. Have the cluster taken out and a single lamp put in the center and so placed that a prismatic glass reflector can be used with it. As with the table lamp, the light which passes through the reflector will iluminate the art glass shade enough to produce the decorative effect, while throwing down the most of the light on the table where it is wanted.

In the general lighting of the room there is usually a waste of one-half the light, more or less, by the use of ornamental globes and shades. We would not have it understood that lighting is not to be decorative, and that all forms of ornamental shades are to be discarded; on the contrary the electric lamp, except where infrequently used, should invariably be provided with some sort of a diffusing shade. Of the various forms of ornamental shades, those of etched or "frosted" glass waste the least light, and those of opal and art glass the most; the latter may use up as much as 80 per cent. of the light given, and their use is justified only where they are to serve primarily as ornaments. Prismatic glass globes are primarily intended to diffuse the light while throwing it down more or less, like a reflector. They therefore actually increase the light underneath, but do not soften it quite as much as frosted or opal globes. They should be chosen where economy is of greater importance than decorative effect.

Frosted lamps soften the light sufficiently for all ordinary purposes, but only last about half as long as the lamp with a clear bulb.

If you find your electric lighting bills too high, look after the following points:

The ordinary size lamp is of 16 candle-power and this is the size that the lighting company will ordinarily furnish you unless you specifically ask for something else; in many cases a lamp of 8 candle-power, or even 4 candle-power will answer the purpose equally well.

All electric lamps fall off in the amount of light with use, a 16 candle-power lamp sometimes falling to 8 or 10 candle-power, while taking nearly the same amount of current. Do not wait for a lamp to burn out before discarding it; as soon as the bulb is so blackened that the filament looks reddish, discard the lamp. Using lamps long after they should be thrown away is one of the most common methods of wasting current.

The ordinary electric lamp gives twice as strong light sidewise as it does through the end. Unless such a lamp has a reflector it throws twice as much light on the side walls as below.

Lamps can be had which give the strongest light through the end; and these should be used where it is not desirable to use a reflector.

If you find the light hard on the eyes, do not at once assume that you need more light, but see that you get the light softened and free from all streakiness, and also that it comes from such a direction as to not shine directly into your eyes or on to a paper in such a way as to blur it.

Remember that fancy tinted and opal globes use up 75% of the light.

Practical Problems in Illuminating Engineering

Remodeling the Lighting of a Bank

BY W. S. KILMER.

The writer was recently called upon to formulate plans for improving the illumination in an office building, the ground floor of which was occupied by a banking office. The installation originally provided had proven very unsatisfactory in the illumination produced, and, especially in view of the poor results obtained, the bills were considered excessive. The installation was no better and no worse than those generally to be met with, and the changes made and results obtained may therefore afford some useful information to those who have to deal with similar problems.

The floor area of the banking office contained 2,035 square feet; the cubical contents of the space was 26,455 cubic feet. In the original installation the general illumination of this space was provided by six fixtures suspended from the ceiling and located as in the plan (Fig. 1). These fixtures consisted of a twelve-inch amber opalescent globe containing 6 16-c. p. lamps closely bunched in the centre; the globe being attached at the end of a brass tube two feet long. The combination was far from being artistic.

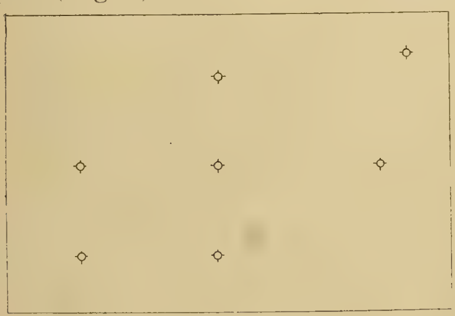


FIG. 1.—LOCATION OF FIXTURES ON CEILING.

In addition to the general illumination provided by these fixtures, 24 individual desk and counter lights were used, the desk lamps being provided with shades in which the lamp was placed lengthwise; the counter lamps were fitted with the regular green and white opal reflector. As clear lamps were used, the illumination from the latter was more or less streaky and uneven.

In the general illumination at least 40 per cent. of the total light was lost by absorption. The calculated efficiency was 1.65 watts per square foot of floor space. In any scheme for improving these conditions re-wiring was obviously to be avoided if possible. It was considered advisable, however, to change the position of one of the chandeliers in order to afford illumination on a large table used by the Board of Directors. The ceiling and side walls were of a sufficiently light tint to be given some consideration, at least as a "factor of safety" in calculating the general illumination.

As arc lamps were out of the question, on account of their undecorative

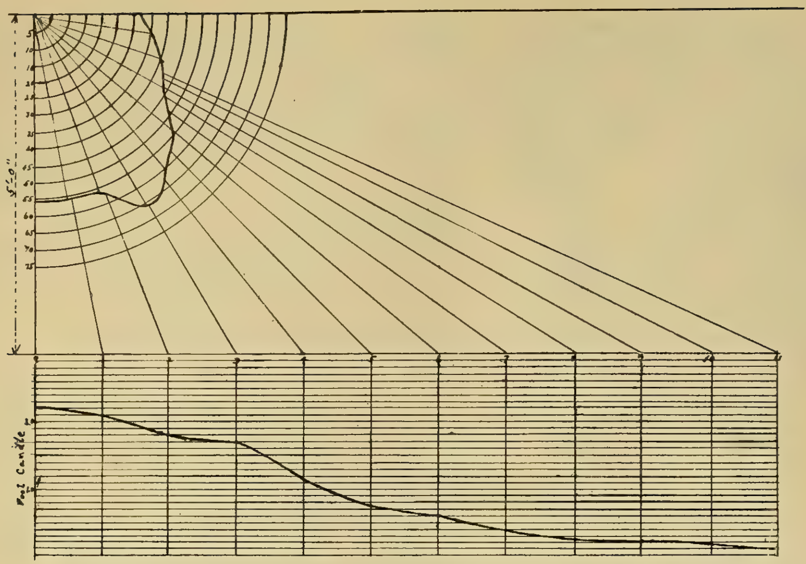


FIG. 2.—CURVE OF HORIZONTAL ILLUMINATION OF UNIT USED.

appearance, if for no other reason, the Gem lamp was selected as affording the greatest possibilities for both economy and effect. It was found that the 187 watt lamp (rated at 75 c. p.), fitted with a distributing type prismatic reflector, and the two placed within a 12-inch Holophane sphere and suspended four feet from the ceiling, would give a reasonably uniform illumination over the theoretical plan, which was taken as 46 inches above the floor, or about the height of the standing desks. The globes were supported by a simple chain fixture in black finish. The curve of horizontal illumination on the assumed plane from one of the globes is given in Fig. 2.

In the special lighting no change was made in the lamps provided with horizontal reflectors; but the porcelain reflectors were replaced with prismatic reflectors covered with green celluloid shades, and 8-c. p. lamps were used in place of 16.

The total current required with the present installation is 1,822 watts, or .89 watts per square foot. This is .76 watts per square foot less than the original installation, which represents a saving of 40 per cent. The present illumination is entirely satisfactory in intensity and quality, and also from the decorative standpoint.

In view of the discussion at the last meetings of the New York Section of the Illuimnating Engineering Society as to the advantages of a white light, such as that from the arc, for the detection of spurious bills, the question was put to the expert of this bank, as well as to several of those who handle the bills. Without exception their opinion was that not only is the white light of the arc entirely unnecessary for this purpose, but that on account of its well-known faults of unsteadiness and high intrinsic brilliancy, it is decidedly undesirable. In regard to counterfeits, the expert said that the bill most commonly counterfeited at the present time is the ten dollar bill having the picture of a buffalo on one side. There are at present six counterfeits of this bill in circula-

FIG. 3.—GENERAL VIEW OF BANKING ROOM.

tion, any one of which, he stated, he could detect "with his eyes shut." This statement was made, not as a mere figure of speech, but as an actual statement of fact. This would seem to indicate that sight is by no means the only way of detecting counterfeits, and that, as between the color of the light of the ordinary incandescent lamp and that of the arc, it can be neglected all together.

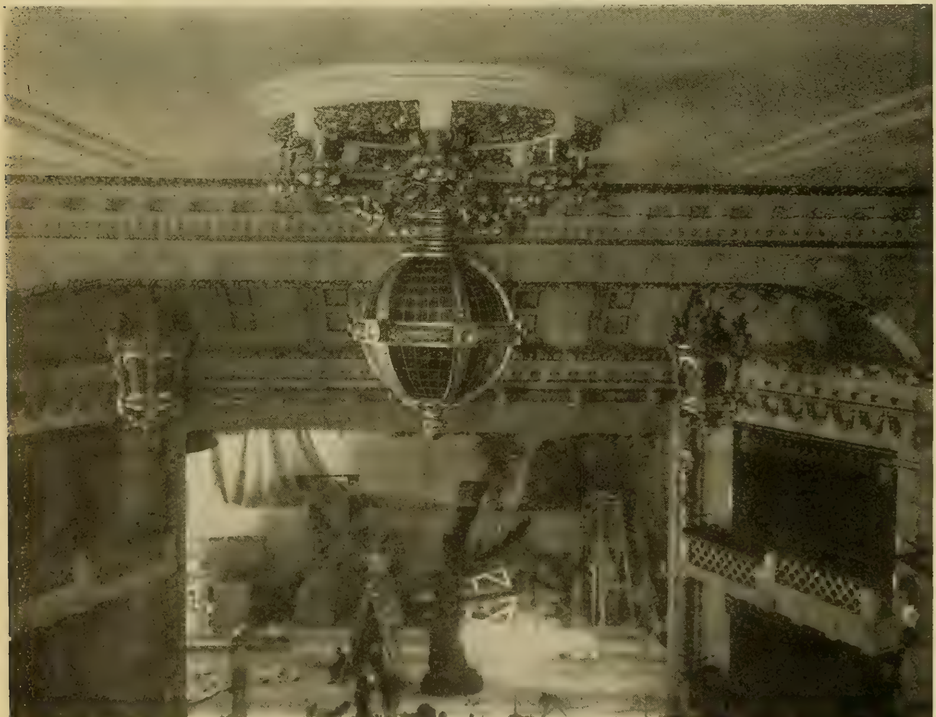
The Proper Surface for Desks and Writing Tables

There is probably no single problem in illumination, the solution of which is so simple in principle, and which is so seldom carried out in practice, as the lighting of a writing table or desk. There are only two points to be looked after; have the light come from the left and slightly in front, and shade the eye from the direct rays. Generally, however, the light is placed squarely in front, and often high enough up to shine directly into the eyes. Add to these defects a highly polished surface, even plate-glass being sometimes used, and a mirror reflector exaggerating the streaks from a bare electric lamp, and the limit of faults is achieved. In no case should a writing table have a polished surface; and where such a surface exists it should be covered with dark colored blotting paper or felt. Glass is a refinement of cruelty to the eyes which should be shunned like trachoma. The bare electric lamp should also be tabooed, and the front position outlawed. An 8-c.p. lamp, with proper shade, and properly placed, will furnish a most satisfactory writing light on a table having a proper surface.

Studies of Notable Instalations

The Astor Theater, New York

This modest little theater is one of the very latest additions to New York's colony of play-houses in the vicinity of Long Acre Square (now Times Square). The interior finish is of a neutral tint, no attempt at color decoration being made. The illustration below is taken from the upper balcony showing the most prominent lighting fixtures. These consist of a large spherical lantern, having clustered lights about it, suspended from a decorative centerpiece on the ceiling, and three lanterns suspended from the main proscenium arch. Figure 2 is an illustration



INTERIOR ASTOR THEATER, NEW YORK.

FIG. 2.

showing the size of the central lantern. The fixture contains twenty 8-c.p. lamps inside the globe, which is set with amber art glass. Surrounding this are two series of clusters, the lower consisting of four of five lights each, the upper eight, of eight lights each. The lamps are sixteen candle-power, round frosted. Nine cluster fixtures are placed under each of the balconies, those around the front containing ten 4-c.p. frosted lamps. There are also four side brackets above each floor. Although no attempt has been made at striking effects in the illumination, it accords well with the general architectural scheme, and is reasonably efficient. Taking the area of the main floor, and excluding the clusters under the upper galleries, the current consumption is practically 1.5 watts per square foot.

The Hall of Records, New York City.

The illustration on the cover shows one of the court-rooms in this very expensive public building. As shown, the chandeliers are of crystal design, and furnish the general illumination of the room. The side brackets and standards on the judge's desk, are fitted with plain opaline globes, the fixtures being of hard chased bronze.

While the defects in the installation are not so monumental as those in the Pennsylvania State Capitol, they are still very apparent. Side brackets, having the same soup-tureen form of shades as those shown in the court room, are used throughout the building. These cut off at least half the light at their best, and at their worst, when covered with the dust and grime that naturally fall upon them, the light underneath is scarcely worth mentioning. The chandeliers were evidently located without regard to the furnishing of the various rooms, as they happen to come directly over the tall filing cases in a number of instances. To remedy this rows of bare 16-c.p. lamps are used along the tops of the cases. In general, the installation is a fair example of the utter subversion of illuminating engineering to the conventional notions of architectural embellishment.

St. Paul's Chapel, Columbia University.

This is a comparatively small building of the basilica order, which has recently been added to the collection of structures comprising the Columbia University buildings. The illustration gives a very fair idea of the architecture and general decorative scheme. The main feature of the lighting installation is the central chandelier, as shown. The design of this chandelier, in a general way, follows the lines of the fixtures used in the early basil-

ST. PAUL'S CHAPEL, COLUMBIA UNIVERSITY.

icas and cathedrals. Occasional side brackets, also shown in the illustration, are intended to supplement this general lighting. The most conspicuous feature of the illumination is its inadequacy for the purpose; and the serious question confronting the University authorities is how to introduce sufficient lighting fixtures to make up this deficiency without either excessively expensive alterations, or unsightly make-shifts in the attempt to conceal outside wiring. Columbia University has long been known as one of the foremost scientific and engineering colleges in the world; and it is to be hoped that this painful example of the need and importance of illuminating engineering will not be lost upon the authorities who determine the curricula of the engineering courses.

Theory and Technology

Daylight Illumination

By O. H. Basquin.

V. Sky Illumination

Continued

Let us now consider with what length of radius, R, the spherical sky surface should be considered to be drawn. Our study of Fig. 16 showed that it does not matter what the radius is. Again, our expression for I, equation 4, may be looked upon simply as a brightness, B, multiplied by a ratio, because F and R^2 are affected in the same way by any change in R or in the unit of length. The radius, R, then may be taken anything we choose, and may be measured in any system of units, provided only that F is measured in like units. In particular we may call R unity and then F must be measured in square radii.

The child thinks of the radius of the dome of the sky as a few miles. We must in our thought make it so small that its projected area can be conveniently measured. In what follows we shall adopt ten centimeters, about four inches, as a convenient sky radius. The projected area will be measured by planimeter in square centimeters, which will become square radii by moving the decimal point two places. Such an area then, when multiplied by the sky brightness, B, will give illumination for a point with respect to which the projected sky has been drawn.

We shall now interest ourselves in the actual determination of the illumination due to direct skylight at a point, A, in a window surface, having given the conditions which limit the sky as seen from that window. This problem is useful in two ways. It forms the basis of an estimate of the possible illumination of the interior, quite separate from the actual means in use for light distribution—in the same way that the discharge and available fall in a stream enable one to estimate the possible water-power at a given locality, whether the power actually developed is much or little. In the second place it is the principal factor in the first and most important term of the series which measures the illumination due to diffuse reflection.

Such problems naturally arise most frequently in closely built parts of cities in which the renting value of floor space is somewhat dependent upon the daylight illumination possible, and in which location also this daylight is likely to be greatly restricted by the presence of neighboring buildings. With regard to the outlines which these city buildings present, it is rather striking to notice that nearly all of them appear in the form of great rectangular blocks set up with one face parallel to the street. The regularity of outline is much greater here than in the more open residence districts.

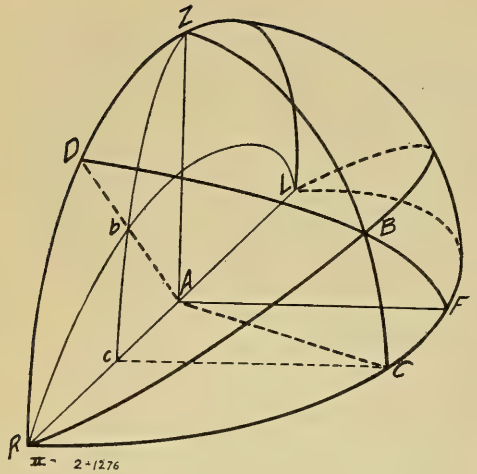


FIG. I.

Practically all outlines fall into three classes, namely, vertical lines, horizontal lines parallel to the street, and horizontal lines running at right angles to the street. Even in alleys and in the light courts of large buildings nearly the same regularity obtains, and we may make use of this characteristic of buildings in devising a ready method of finding illumination.

We have seen above that projected sky area when multiplied by sky brightness gives illumination. Our end will be attained by agreeing upon an easy method of finding the projected sky area. We take A as a point on a vertical window or wall. We wish the illumination at A. Imagine the small sky sphere of 10 cm. radius with its center at A. For the representation of the sky we evidently need only one-quarter of this sphere, *i. e.*, the part in front of the window and above a horizontal plane through the center. We shall generally think of the observer as standing with his eye at A, looking out of the window at the interior of the globe and at the neighboring buildings. A horizontal line through A and paralled to the street touches the sphere at the observer's right and left in two points which we may call the right point and the left point, respectively. These points may be designated by R and L, respectively. A vertical line through A strikes the sphere in the zenith point, Z. A horizontal line through A and at right angles to the street strikes the sphere in a point

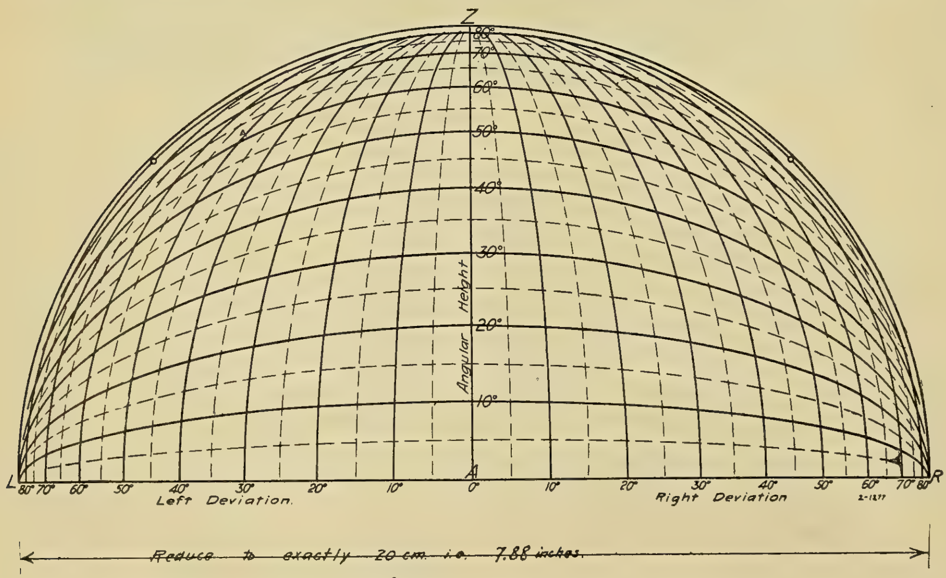


Fig 2.

called the front point and designated by F. These points are shown in Fig. 1, in which the quarter sphere is viewed from the outside for convenience in drawing.

Let us now imagine that on the opposite side of the street from our window there is built a very long and tall fence, such as is sometimes put up for bill-posters, of uniform height throughout its length. From the eye at A the view of the lower part of the sky will be cut off by this fence. Imagine a plane passed through A and through the top of this fence. It cuts the sky sphere, Fig. 1, in the half great circle RBL. It is evident that the sky is all obstructed below this line, provided the fence extends up and down the street as far as one can see. The window plane is the one in this figure which contains the letters R, D, Z, L, A, b and c. The projection of the half great circle RBL on the window plane is shown as the ellipse RbL. The whole projected area of the unobstructed sky is the half circle $RDZLAcR$. The fence cuts out the whole portion below the ellipse, RbL. The area above this ellipse when measured and multiplied by the sky brightness gives the illumination at A when the long fence is in place.

The dihedral angle between the plane RBL in Fig. 1, and the horizontal may be called the angular height of the fence, and may be designated by h. It is evident that the ellipse RbL in this figure is one whose major axis coincides with RL and whose semi-minor axis is the sky radius multiplied by the sine of the angular height h. In Fig. 2 is shown a chart of the projected sky, corresponding to $RDZLAR$ of Fig. 1. The half ellipses running from the left, L, to the right, R, are the ellipses corresponding to the tops of uniformly high fences or building fronts, parallel to the street. These curves are given for various angular heights, enabling one to interpolate the curve corresponding to any given angular height likely to be met in practice.

Let us return to Fig. 1, and now assume that the fence has been removed from the left part of the horizon as seen from A, giving an open sky from L to C at which point the fence begins with a vertical post and continues from there around to R, as before. How shall the vertical edge at C be represented? Pass a vertical plane through A and through the post at C. This plane cuts the sky sphere in a great circle a quarter of which is shown as ZBC. The post is evidently represented on the sky sphere by the arc BC, *i. e.*, the part of ZBC below the half circle RBL which represents the top of the fence. The projection of ZBC on the window plane is shown as the light line Zbc, in Fig. 1. In this figure the fence is represented by the projected area, $RbcR$.

The position of any vertical edge may be designated by giving the angle which its vertical plane through A makes with the plane through F, *i. e.*, the angle FAC in Fig. 1. We may call this angle a deviation to the right or a right deviation when the vertical edge in question is at the right of F as in the figure, and a corresponding point on the left of F may be said to have a left deviation. In Fig. 2 the vertical edges are represented by the quarter ellipses which start at Z and run down to the line LAR, cutting it at right angles.

There is still a third kind of outline not yet discussed, the line at right angles to the plane of the window. Return again to Fig. 1, and imagine now that the fence from the corner BC extends at right angles to the street and is built of uniform height with the first portion. Its top forms

what may be called a receding edge. How shall it be represented? Pass a plane through *A* and through the receding edge. It cuts the sphere in the great circle *DBF*. If the fence extends *away from* the window as far as one can see, it will be represented on the sphere by the area below the curve *BF*, but if it is built from *BC* *toward* the window, like a boundary fence in a back garden, then it becomes a more serious matter as far as illumination goes, and is represented on the sphere by the area below the line *DB*.

The plane of the curve *DBF* is at right angles to the window. The projection of *DBF* on the window plane is therefore a straight line, *DbA*. The lines representing receding edges are not drawn on the chart, Fig. 2. They are simply straight lines passing through *A* and each line may be drawn as needed without complicating the figure with this extra set. Any point on the sky is located on this chart by giving its angular height and its deviation. The receding edges do not need a separate set of angles for their designation, at least for most cases.

In order to understand the method of using Fig. 2, let us consider the conditions shown in Fig. 3, which

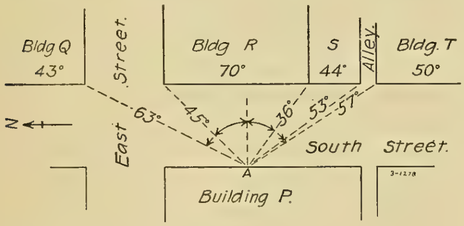


FIG. 3.

approximately represents a busy corner in the down-town district of Chicago. *A* is a point about 5 feet from the walk on the east face of the building *P*. Opposite this is an office building, *R*, less than ten years old. The other buildings shown are not of recent construction, and are much lower than the building *R*, as shown by their smaller angular heights, the numbers on the building spaces in the figure. The numbers on the dotted lines radiating from *A* are the various deviations of the building corners from the front point, these terms being explained above.

Now in order to draw the projected sky diagram for these conditions, one may stretch a piece of tracing paper over Fig. 2, and draw the diagram on it using the curves on the chart below as guides. Fig. 4 represents

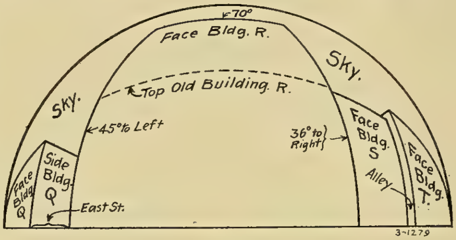


FIG. 4.

such a projected sky diagram for the conditions of Fig. 3. As the building *R* is the most prominent object on the horizon at *A* we may start with it. Beginning with a left deviation of 45° and a right deviation of 36°, sketch the arcs of ellipses for the vertical edges running up to an angular height of 70°. The upper ends of these curves just drawn are joined by tracing along the curve of 70° angular height to represent the top of the front of building *R*. Now take building *Q*. With a left deviation of 63° draw a vertical edge up to an angular height of 43°, and then follow this 43° curve toward *L*, to represent the upper edge of *Q's* front: The receding edge of *Q* is put in as a straight line beginning at the intersection just drawn, of left deviation 63°, and angular height 43°. This straight line is drawn toward *A*, but it must not pass the left corner of the building *R*. Buildings *S* and *T* are

sketched in in the same manner. Sketching in the semi-circle above, our projected sky diagram is completed.

Taking a planimeter and tracing the boundary of this projected sky, we find its area to be 30 square centimeters. Since our sky radius is 10 cm. and our area must be expressed in square radii, we must move the decimal point to the left two places. Now multiplying by 250 ft. candles, the sky brightness, we find the illumination at *A* to be 75 ft. candles. This seems a great illumination when compared with that commonly used in interiors, but it must be remembered that only a comparatively small proportion of this light can in general be thrown into the interior of the building, and that the interior is always large in comparison with the window space and hence a great intensity is required at the window surface to produce much result inside.

The angular height of the old building which the present building *R* replaced was about 45°. This is indicated by the dotted line in Fig. 4. Reducing *R* to this angular height increases the projected sky area by 0.19 square radii, and the illumination by about 47 ft. candles. When the new building at *R* went up, the illumination at *A* was thus decreased about 40%.

If one wishes to find the illumination for other windows in the east face of building *P*, Fig. 3, the angular heights of the buildings given in that figure will hold good for any window at the same elevation above the walk as the window *A* for which the figure was drawn. For these other windows on the same floor with *A*, one needs simply to sketch in on Fig. 3 lines from the building corners to the windows in question and measure the deviations with a protractor.

If one knows the heights of the various buildings opposite a window, the angular heights are easily obtained by drawing a vertical section through the window and the street, marking off these heights on the line representing the opposite building face and measuring the various angles with a protractor. It may be inconvenient to make inquiries as to the actual height of surrounding buildings. In such cases one can easily obtain the necessary information by means of a small clinometer shown in Fig. 5.

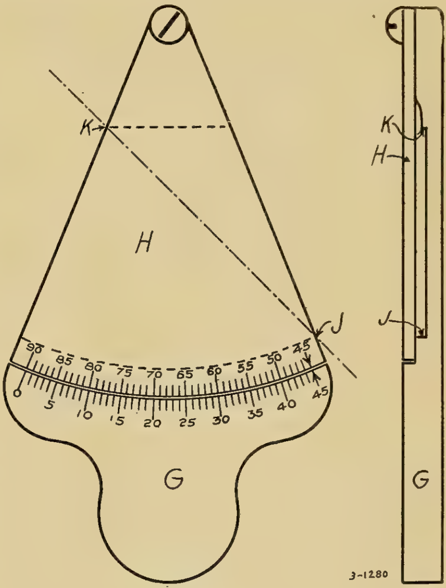


FIG. 5.

This clinometer is composed of two pieces *H* and *G*, joined by the screw at the top. *H* is a pendulum freely swinging in its own plane. One supports the instrument by taking the lower part of *G* between thumb and finger. Behind the swinging pendulum there is seen a slot through which one may look. One can sight over the corners *J* and *K* of this slot, making them fall into line with the top of the opposite building. This is suggested by the dot and dash line *J-K* in the front view of this figure. When

this alinement is seen to be satisfactory the pendulum H is clamped against the support G by touching it with a finger. The reading of the angular height is given in degrees opposite one of the arrows shown at $45°$. For angular heights smaller than $45°$, the reading is on the lower scale, while it is on the upper scale for greater angles. It will be noticed from our definition of angular height that it must be measured in a plane at right angles to the window plane. On a north and south street one must not look in a northeasterly direction and take a reading. The reading for each building must be made opposite that identical building.

It is generally sufficient to make these observations from the sidewalk level, standing with one's back against the face of the building for which the illumination is required. One can correct these angular heights for windows of any elevation above the walk by drawing a section. The ground plan is obtained from a good map or by measurement. A beginner will need to use a tape or folding rule in taking these dimensions, but later practice will enable him to depend upon pacing for many of these less important measurements.

The chart of the projected sky and its method of use form the key which opens up an easy and accurate method of estimating the illumination due to the direct radiation from the sky. In Molesworth's *Obstruction to Light* is given a figure quite similar to this chart and is called by the author a planisphere, but the book does not contain a suggestion that the illumination is proportional to the area of the projected sky, the diagram being used simply as a convenient means of representing a spherical area on a plane surface.

Blondel's System of Arc Lighting

By Isidor Ladoff.

The idea of improving the properties of ordinary arc light carbon pencils by the addition to the mass of these pencils of various mineral substances does not represent anything new. Casselman (Poggendorfs' Annalen, 1844, vol. 63) introduced into electric carbons borates, sulphates and boric acid.

In order to *lengthen the life* of the carbon pencil, Wortley (French Patent No. 129,636, 1879) adds silicates to the paste. Lacombe (French Patent No. 509,170, 1890) adds to the same sulphates, chlorates, phosphates, etc. Boric and phosphoric acid are added to the carbon paste for the same purpose by carbon manufacturers. Mignon and Rouart (No. 143,206, 1881) claim a vitrified exterior coating. Julien (French Patent No. 265,661, 1896) recommends the same process with the addition of silicates, tungstates, the salts of lime, magnesia, soda and potash.

More than a quarter of a century ago (1876) Gaudin, Carre (1886) and Archerau (1878) in France discovered the property of mineralized carbon pencils, especially the properties of carbon pencils to which limestone, magnesia and similar substances were added. In the same manner numerous researches have been made with various components, such as carbides, oxides, fluorides, etc., of different metals. Du Moncel in his treatise of 1883 on this subject reports that

so far nobody knew how to apply these lighting properties of mineralized carbon in a practical fashion, on account of the formation of slags and the instability of the arc.

Carre (1886, French Patent No. 174,268), namely, recommended the addition of a half per cent to ten per cent of the carbonates, borates, or acetates of sodium, potassium or barium, or boric acid as we have seen. Wortly, in 1879, indicated the addition of one to one and a half per cent of magnesium silicate. Lacombe (1890) advised the addition of sulphates, chlorides, phosphates, phosphoric acid, etc. Nobody advised the addition of any substance to the mass of the carbon more than in the proportion of two per cent. Numerous European and American inventors proposed the use of all imaginable chemical substances and their combinations for the indicated purpose. Mr. Weston, for instance, in America, took out a patent (No. 210,380) for making a carbon having the form of a tube, the hollow part of which was filled with materials or substances that were claimed to produce a quieting effect on the arc. In this patent, will be found a long list of such substances. On July 5, 1879, Louis Siemens took out a German patent (No. 8,253) wherein he claims a solution of a substance in which the carbon is suspended. This solution is then forced under pressure into the hollow carbon tube. The carbon is then dried. With this patent, later on, Siemens brought suit for infringement against all German carbon manufacturers making a cored carbon, and his patent was granted, not on the claims of the invention of the core, but on the process of forcing the coring mixture into the carbon, by using pressure. In England, however, Siemens' patent was cancelled or rejected on account of the patents of Jablochkoff (German Patent No. 663) and Weston (1878, U. S. Patent No. 210,-380.) The particulars may be found in a publication by Hippolite Fontaine, 1878-1879. Bremer exhibited a lamp with mineralized carbons at the Exposition of 1900 and attracted general attention to this subject. However, he has been stopped by the formation of slags and could not obtain good results with the ordinary disposition of the carbons, as he stated himself (*Electrotechnische Zeitschrift,* April 4, 1901, page 304) and as stated in the report of the International Society of Electricians (1901, page 364, France) on the authority of the Central Laboratory of Electricity. Bremer was forced, accordingly, to prefer a new type of lamp, in which the two carbons are placed obliquely, converging towards their lower ends, which occasions many inconveniences. This disposition of the carbons has been copied by numerous lamp designers, who adopted for the carbons a coring system. None of these systems were satisfactory. The entirely mineralized carbons produced excessive slagging. Carbons with strongly mineralized cores operate acceptably only with an excessively high current that causes a too rapid burning short life. Furthermore, up to this time one could not use lamps of low current intensity with strongly mineralized carbons, one could not render practical a current consumption inferior to six or seven amperes, and, in reality, the German lamps work under the intensity of nine amperes and above. It is true one can thus obtain an increase of light, but with a sacrifice in economy.

Criticising the mineralized pencils in general, A. Blondel points out their following four principal defects:

(1) Their low conductivity,
(2) Their short life,
(3) The excessive formation of slag,
(4) The unquietness of the arc produced by them, its lack of uniformity in time and space.

The three first defects A. Blondel claims to have remedied by the use of an envelope of pure or only slightly mineralized carbon. The fourth defect he remedies by the use of multiple mineralized cores. The outer envelope of carbon is very thin—0.5 to 1.5 mm. in general, as he considers it advisable that it should be consumed more rapidly than the main body of the pencil. He recommends. for example, for a 5-ampere current lamp, a pencil of 7 mm. in diameter. The mass of the pencil should contain forty to sixty per cent of fluoride of calcium (to this may be added carbide of calcium, or other mineral ingredients).

The inventors of mineralized carbon pencils, prior to A. Blondel, tried to steady the arc by the following principal three methods:

(1) By the use of a core of lower specific resistance than the mass of the pencil; by the addition of metallic powders, or by the use of a wire.

(2) By the additions of salts of lime, magnesia, etc.

(3) By the addition of less than twenty-five per cent of alkaline salts to the carbon paste.

The remedy proposed by A. Blondel consists in the enhanced mineralization of the pencils (twenty-five to eighty per cent) distributed and localized in multiple cores.

He especially recommends the following substances: Silicate of potassium, borate of potassium, fluo-silicate of potassium, tartarate of potassium, boro-potassium, tartarate, double-fluoride of aluminum and sodium.

For the purpose of modifying the color of the flame he proposes the addition to the paste of the core besides the enumerated *stimulating* salts (excitateurs) salts of barium, strontium, lithium, magnesium, calcium, etc., in quantities at least twenty per cent of the previous salts. (See his French Patent No. 323,813, March 16, 1903.)

In order to increase the life of the carbon pencils, A. Blondel proposes the addition of four to five per cent of alkaline borates, phosphates, carbonates, acetates, tungstates or silicates of alkalines, also boric acid, etc. A. Blondel claims that these substances do not lower the luminosity of the flaming arc produced by the mineralized pencils. (See his French Patent No. 323,814, April 2, 1903.)

Blondel uses his positive mineralized pencil as the lower electrode, claiming for this arrangement a higher efficiency.

The nature of A. Blondel's system of pencils for arc light will be best explained by the following description with the accompanying drawings, taken from the United States Patent No. 714,277.

Fig. 1 is a view, partly in side elevation and partly in section of an

FIG. 1. FIG. 3.

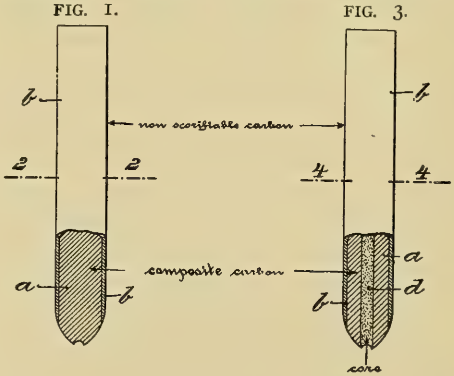
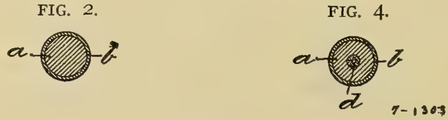


FIG. 2. FIG. 4.



U. S. PATENT NO. 714,277.

electrode, embodying main features of my present invention. Fig. 2 is a cross-section view taken on the line 2-2 of Fig. 1. Fig. 3 is a view similar to Fig. 1, but illustrating a modified form of electrode; and Fig. 4 is a cross-sectional view on the line 4-4 of Fig. 3.

Referring to Figs. 1 and 2 of the drawings, *a* represents the main body of the carbon, formed preferably of carbon mixed with a large proportion of coloring and light-producing salts. The body *a* is inclosed by a coating *b* of non-scorifiable carbon. This coating *b* forms a substantially thin layer, within which the body *a* is inclosed, and it consists of either pure carbon, or carbon combined with a small percentage of the coloring and light-producing salts.

In Figs. 3 and 4 a cored electrode is shown wherein the main body *a*, of carbon combined with a large proportion of the coloring and light-producing salts, incloses a core *d*, of alkaline salts—such, for instance, as tartrates, carbonates, borates, silicates of sodium or potassium, etc., which, if desired, may also be mixed with coloring and light-producing salts. In this form of the invention the body *a*, which encircles the core, *d*, is itself encircled by the coating *b*. of non-scorifiable carbon, as in the first form illustrated in Figs. 1 and 2.

In the carrying out of the invention it will be found that the following proportions are practicable: The body *a* is of seven millimeters diameter, and the coating *b* is from one to two millimeters in thickness. Where a core *d* is used, the body *a*, of seven millimeters, is hollowed to receive the core *d*, of two millimeters diameter. In ordinary cases the body *a* is formed of a paste containing about equal quantities of carbon (such as used in the manufacture of ordinary electrodes) and of fluorid or phosphate of calcium, and the coating *b* is formed of pure carbon. The core *d* is made of the alkaline salts used ordinarily in the fabrication of low voltage and cored carbons—namely, the tartrates, carbonates, etc., of sodium or potassium, etc.

The function of the core is to give fixity or steadiness to the arc, and the presence of the core is not absolutely essential. When desired, if the core is dispensed with the steadiness of the arc may be enhanced by mixing with the paste forming the body *a*, of the lamp, the alkaline salts or by impregnating the cylinder *a* after the paste has been heated to form the cylinder or pencil. It will be found that either in the core *d* or in the body *a* of the electrode the best results, so far as steadiness of the arc is concerned, will be obtained by using the salts of potassium. The thickness of the coating *b* may vary according to the circumstances under which the electrode is used. Under any circumstance, however, the coating *b* must burn a little more rapidly than the inclosed body *a*, so that the point of the composite body *a* may stand out some millimeters below the lower edge of the coating *b* and the arc form itself upon said point and not upon the coating *b*. If the positive electrode is used as the upper electrode of the lamp, it will be found that the coating *b* will burn more quickly than if the positive electrode is used as the lower electrode. Hence a difference in the thickness of the coating *b* under these varying conditions must be made. Again, pure carbon burns more rapidly than carbon combined with a small proportion of the light-producing salts, and hence this also must be considered in coating the electrode. In preparing the electrode either of the following methods may be used:

First.—The body of the carbon is

made according to the usual continental method—namely, by drawing through a drawing-plate, a paste formed of the mixture containing from ten per cent to ninety per cent of carbon and ninety per cent to ten per cent of the rare-earths, such as the salts of calcium, magnesium, thorium cassium, or the like, aggregated with tar under pressure. The pencils or rods are made either with or without the central bore, into which the core is to be introduced. They are then dried and cooked at a temperature sufficiently low not to volatilize the salts. After this the rods or pencils are introduced into a press containing carbon and tar and the coating pressed upon the rod or pencil. The whole is then cooked. The press used in applying the carbon coating is similar to that used in covering cables with a coating of lead.

Second.—A special drawing-press is constructed with two or more cylinders containing respectively the material for the body and the material for the coating of the rod or pencil. The cylinders feed through concentric pipes or separated pipes feeding concentric chambers, and the exit is through annular concentric drawing-plates. In this instance, the electrode is made at one operation and needs only to be cooked and its core filled in the ordinary manner.

Third.—The body of the pencil and the cylindrical coating are each made separately of the respective mixtures by the press, and then one is introduced into the other before the cooking process or after each has been separately cooked.

Andre Blondel proposes the use of a system of cores as shown in Fig. 1, representing a carbon of fifteen millimeters in diameter; Fig. 2 representing a pencil of ten millimeters in diameter, and Fig. 3, representing a pencil of seven millimeters in diameter. The principle of the invention consists in the realization of a volume for the coring material equal to one-fifth to one-half of the total section of the pencil, a proportion that cannot be obtained with one single core, that would have to occupy 0.5 to 0.7 of the total diameter, which is impracticable. The employment of multiple cores besides this allows the introduction of considerable mineralization diluted in a considerable quantity of carbon paste. The combustion of the carbon in the arc goes on regularly while the arc is fixing itself alternately from one to the other core in the measure as one after another of these cores is being holed out deeper and deeper. The composition of the carbon paste, the mineralization and the number of cores is being regulated so as to equalize the rate of combustion to the rate of volatilization of the minerals in the cores and the arc is saturated constantly with mineral vapors. To the pencils destined for ordinary industrial use the coring material is supplied not only with a strong proportion (at least thirty per cent) of light-producing salts (*sals e'clairantes*) as the salt of lime, magnesia, etc., but also with considerable proportions of stimulating salts (*sals excitateurs*) i. e., salts concentrating the arc and making it more brilliant, as, for instance, borates, silicates, carbonates, tartarates of potassium, cryolite, etc. For instance, the coring material is composed of twenty to thirty per cent of carbon powder, fifty to seventy per cent fluoride of calcium and ten to twenty per cent of salts of potassium. The paste is agglomerated in the usual manner, either by a solution of a silicate, a gum or tar.

In his French Patent No. 323,924, March, 1903, A. Blondel says, among other things:

"The multiple cores may be used

also with carbon pencils, whose body is strongly mineralized itself. In that case the degree of mineralization of the body of the carbon may be identical with that of the cores or the cores may not be mineralized at all. For instance: In case the paste of the body of the pencil contains already light-producing salts (as fluoride of calcium, for example), the cores may contain only stimulating salts, as borate of potassium. It is even preferable to increase their proportion by imparting to it more than forty per cent of the coring mixture, because it is harder to steady the arc when the principal body of the pencil itself is mineralized. If it is advisable, for instance, to obtain electrodes formed of a paste containing forty to fifty per cent of fluoride of calcium with cores containing twenty-five per cent of the same salts, forty to fifty per cent of borates of potassium or simply fifty to sixty per cent of borates may be added to the cores. It is claimed for the Blondel system of carbon pencils that they allow the use of a lamp of 3.3 amperes, which gives a light fifty per cent superior to the ordinary lamp of ten amperes, and six and one-half times more light than a lamp of 3.3 amperes of the old system. For a ten-ampere lamp, of Blondel's system, it is claimed that it gives seven times as much light as an ordinary 10-ampere lamp.

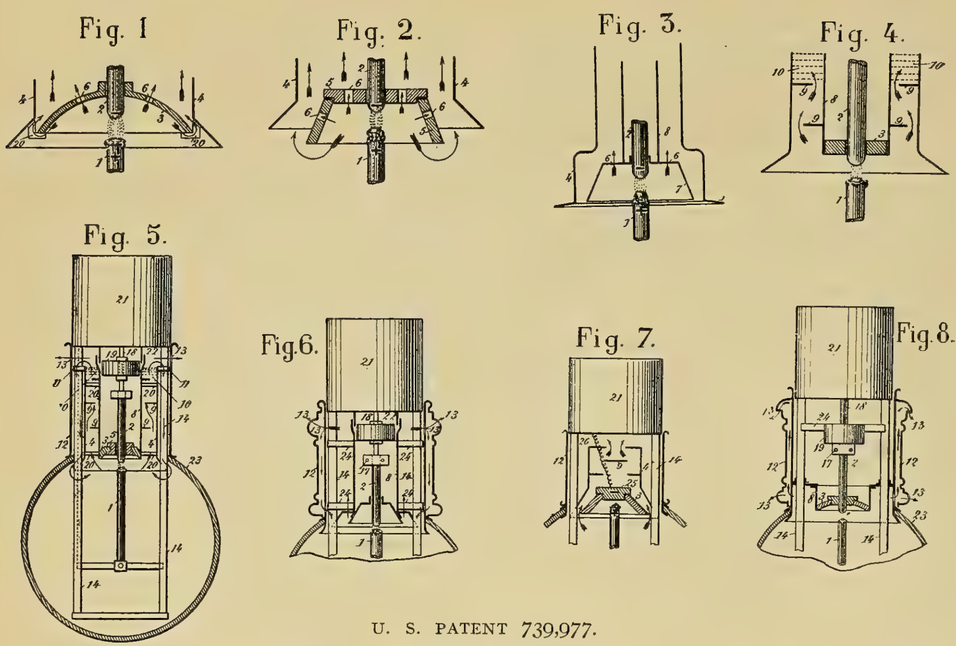
Our description of the A. Blondel system would not be complete without a description of the lamp invented by A. Blondel, for his pencils.

The principal objects of the present invention are: First, to provide in an electric arc lamp two vertically arranged carbons, one, the lower and positive carbon, being mixed with the light-producing salts, and the other, the upper electrode, either of carbon combined with a small percentage of these salts or of pure carbon and the upper carbon provided with a refractory shield or plate encircling the carbon above the arc formed between the carbons. Second, to provide in an electric arc lamp in addition to the two carbons and the refractory shield or plate upon one of said carbons, a smoke-consumer or draft-passage located concentrically with the carbon upon which the refractory shield or plate is arranged. Third, to provide in an electric arc lamp, wherein a composite carbon is opposed to a substantially pure carbon, a combined means of preventing the accumulation of scoria upon the carbons and the diffusion of smoke and vapors about the luminous center of the lamp, as well as for securing an increase in the luminosity of the arc by refraction.

The nature and scope of A. Blondel's invention will be more fully understood from the following description, taken in connection with the accompanying drawings of U. S. Patent 739,977, forming part hereof in which:—

Fig. 1 is a vertical sectional view illustrating diagrammatically the carbons, refractory shield, and smoke-conveyor embodying main features of the invention. Figs. 2, 3 and 4 are views similar to Fig. 1, but each illustrating a modified form of the invention. Fig. 5 is a vertical sectional view, partly in elevation, of a lamp wherein the invention is embodied in a still further modified form; and Figs. 6, 7 and 8 are views similar to Fig. 5, but each illustrating a still further modified arrangement of carbons, refractory shield, and smoke-conveyer.

Referring to the drawings, and particularly to Fig. 1, the lower carbon 1 is preferably the positive electrode of a continuous-current lamp, and as such it consists of carbon mixed with the light-producing salts, either in block or having a core of such com-



U. S. PATENT 739,977.

posite carbon surrounded by pure carbon. This lower carbon 1 in an alternating-current is the alternative electrode. The upper carbon 2 is preferably the negative electrode of a continuous-current lamp, and as such it is essentially of pure carbon with a slight percentage of the light-producing salts either in block or in its core. It may, if desired, be formed of pure carbon with a composite covering. In alternating-current lamps this carbon 2 is an alternative electrode. Upon this upper or negative carbon 2 is arranged a shield or plate 3 of refractory material or metal. This shield or plate may be of any preferred shape or form, as illustrated in the various figures of the drawings, so long as it accomplishes the two-fold function or purpose of protecting the upper carbon 2 from vapors arising from the arc by condensing said vapors on its under surface, as well as reflecting the light from above the arc downward from that surface upon which the vapors are condensed. In Fig. 1, the plate or shield 3 is spherical and is provided with openings 6, through which those vapors may escape which are not condensed upon the shield or plate. Concentric with the rim or lower edge of the plate or shield 3 is a tube 4, having a lower flaring or conical edge, extending preferably below the shield or plate 3. This tube 4 forms a flue or chimney into which the smoke is drawn upward, as indicated by the arrows. The tube 4 also forms, preferably, the support for the plate or shield 3, having for this purpose the brackets or claws 20, on which the lower edge or rim of the plate or shield 3 rests.

In Fig. 2, the construction is substantially the same as in Fig. 1, with the exception that in this form the refractory plate or shield 5 is cup-shaped and inverted over the arc formed between the carbons 1 and 2. The base and conical walls of the cup-shaped plate or shield 5 are both perforated as at 6, to permit the escape of the vapors to the interior of the tube 4.

In Fig. 3, the shield or plate 7 is of inverted-cup shape, as in Fig. 2;

but in this form of the device a tube 8, concentric with the upper carbon 2, projects from the roof of the shield 7 and surrounds the carbon 2 to protect it from the smoke and vapors in the smoke-conveyer 4, which surrounds the tube 8.

In Fig. 4 the shield 3 is flat and arranged at the base of the tube 8. Between the tube 8 and the encircling smoke-conveying tube 4 are arranged baffle plates 9 and wire gauze 10, through which the smoke and vapors must pass to facilitate the deposit of soot from the smoke.

In Fig. 5 the general arrangement of a lamp is illustrated. In this figure the shield or plate 3 projects downward from a collar 5, secured to the carbon 2, and is inclosed by the tube 8, which protects the carbon 2 from the smoke and vapors in the conveyor 4. The conveyor tube 4 has claws or brackets 11 encircling the vertical supporting tubes 14 of the lamp and are adapted to slide thereon to form a means for elevating or lowering the conveyor 4 with respect to the arc between the carbons 1 and 2. The holder 15 for the lower carbon 1 consists of a cross-bar sliding in the tubes 14. Through one of said tubes 14 extends a chain 16, connecting the feeding mechanism (not shown) with the lower carbon holder 15. The smoke conveyer 4 is surrounded by the casing 12 of the lamp and is by preference perforated, as at 13, above the discharge from said conveyer 14. The rod 18 of the upper carbon-holder 17 is operated by a feeding mechanism (not shown) and to the rod 18 is secured a counterweight 19, both weight 19, carbon-holder, and upper carbon 2, sliding up and down in the protective tube 8. The conveyer tube 4 supports the protective tube 8 through the intermediary of claws or brackets 20. The feeding mechanism for the carbons 1 and 2 is inclosed in the casing or shell 21. The tubes 8 and 4 slide up and down, as before explained, upon the supporting-tubes 14 of the lamp, and when an upper carbon 2 is to be replaced both tubes 4 and 8 are lowered sufficiently to permit of access to the carbon 2 and its holder 17. A short tube 22 serves to close the upper end of the protective tube 8 when the same is elevated into operative position. A globe 23 incloses the arc between the two carbons.

In Fig. 6, the construction is similar to that illustrated in Fig. 5, with the exception that the smoke-conveyer consists of the casing or shell 12 of the lamp.

In Fig. 7 the principal difference between the modification shown and the modifications of the other figures consists in replacing the upper negative carbon 2 by a block 25 of pure or substantially pure carbon or of refractory material mixed with carbon and with a metal. In this form, 26 represents the conductor leading the current to the negative pole or block 25.

In Fig. 8 a still further modification of the lamp is illustrated, wherein the protecting tube around the upper carbon is dispensed with. In this form, however, the space wherein the carbon 2 slides is inclosed by the casing 12, the casing 21 and the shield or plate, 3, supplemented by the tubular extension 8, and plate 27 on said shield or plate 3. In this form the passage for the escape of smoke or vapors is formed in the casing 12, having outlets 13.

The advantages of the above described arrangement are many. By placing the composite positive carbon below the upper and negative carbon, a curious phenomenon arises, which explains why but small results were obtained heretofore from continuous-current arcs in which the composite alternative or positive carbon was arranged above the negative carbon.

The Influence of Color on Illumination

By J. S. Dow.

Probably nothing has been more effective in bringing home to the general public the immense changes which are taking place in our methods of illumination, than the remarkable diversity of color of the lamps which now illuminate our streets. Whereas, a few years ago, yellow was the predominant hue only varied by the occasional white of the pure carbon arc, we have now the enclosed arc, the flame arc, the incandescent mantle, and the mercury arc, each having its characteristic and peculiar color.

The introduction of new sources of light, which utilize incandescent vapors and which therefore exercise selective radiation, will probably not only lead to still further color differences, but will also eventually enable us to completely control the spectrum of our illuminants.

Illuminating engineers, therefore, will shortly be called upon to decide not only the nature of the spectrum which gives the best general results in illumination, but also the particular portions of that spectrum which are most serviceable for particular uses. In this article the writer wishes to indicate the chief principles which will influence their decision, and to point out a few of the many disputed questions regarding which further information is desirable.

At present we are prevented from realizing, artificially, the ideal conditions of daylight illumination in our streets by considerations of pounds, shillings and pence. We cannot afford the necessary energy and therefore, for some time to come, the most important factor in light productions will be efficiency. At ordinary illuminations the greatest luminous efficiency is in the neighborhood of the yellow in the spectrum.

In Fig. 1 are shown two curves (thick) representing the distribution of illumination and energy respectively, in the solar spectrum.

The curve of luminosity is that obtained by Sir Wm. Alney and the energy curve is due to Nicholls.

The maximum of the curve of distribution of energy lies, in general,

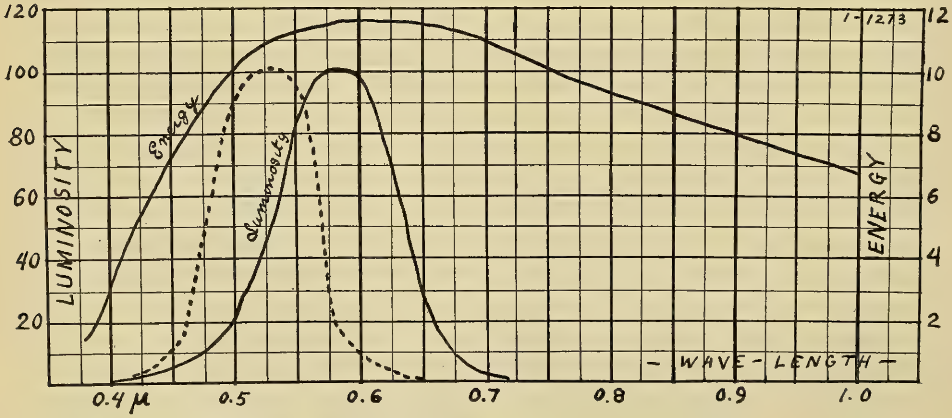


FIG. 1.—CURVE SHOWING DISTRIBUTION OF ILLUMINATION AND ENERGY IN THE SOLAR SPECTRUM.

far out in the infra-red invisible portion of the spectrum, in the case of incandescent solids.

The light from the sun is mainly due to incandescent solid particles, but, at the enormous temperature of the sun, the maximum of the energy curve occurs in the visible portion of the spectrum, *i. e.,* the spectrum as it reaches us. Professor Langley's well-known experiment leads us to suppose that the maximum of the energy curve is really out in the ultra-violet. But our atmosphere filters out these rays of short wave length to such an extent that the maximum of the energy distributed in the spectrum, as it reaches us, is in the neighborhood of the orange and yellow. By dividing the luminosity by the corresponding value of the energy throughout the spectrum we obtain the curve of luminous efficiency shown in Fig. 2.,

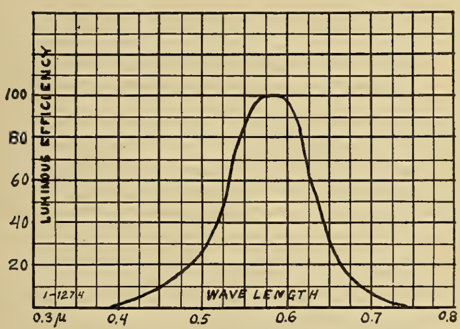


FIG. 2.—CURVE OF LUMINOUS EFFICIENCY OF SOLAR SPECTRUM.

which shows that, for a given amount of energy reaching the eye the greatest luminous effect produced is in the yellow.

It is interesting to note that this fact is seemingly, simply the result of the energy maximum of the solar spectrum being where it is. Our eyes have adapted themselves to the most economical use of sunlight.

But it must be remembered that this result only holds good at ordinary illuminations when the "cones" in the eye are in action. When the illumination is reduced to the point at which the "rods" become the predominant organs, the distribution of luminosity is entirely altered to the state of things shown by the dotted curve, and the blue and green are then the most useful portions of the spectrum. In any particular case, therefore, when the illuminant is, unavoidably, very weak indeed, such sources of light as the mercury vapor lamp, with its strong green element give the best results.

The general conclusion to be drawn from the curve in Fig. 2 seems to be that yellow light is so much more easily produced than light in the adjacent portions of the spectrum, that even though light of another color may occasionally be more efficient for a particular purpose, it will generally pay us to use yellow light.

This has recently been emphasized by the gain in efficiency which follows the superimposing of the vivid yellow calcium line over the main carbon spectrum in the flame arc. In the "Carbone" arc the close approximation of the spectrum to that of sunlight is inevitably accompanied by a loss in efficiency.

But, again, it must be remembered that as a rule we generate a great deal of useless energy in the form of heat. Hence it is quite possible that a particular selectively radiating illuminant may contain practically no yellow light, but may nevertheless have, what we at present consider a high efficiency, simply because it produces no energy in a non-luminous form. It may, in fact, generate light energy only, although not of the best illuminating quality.

Therefore it is quite possible that we may presently have to deal with a very efficient light indeed which nevertheless contains nothing but

green or red light. If on this account only, it is important to understand how the illuminating properties of a source are dependent on its wave length. But we must also remember that, even when using white light, we are constantly called upon to illuminate color surfaces which involve the same conditions.

Now one peculiarity of the eye which would certainly be strongly in evidence with a light of the above description is the "yellow spot" effect. The central portion of the retina—the yellow spot—is very much less sensitive to the violet end of the spectrum than the surrounding portion of the retina is.

The result is that the relative brightness of a red and green object depend upon the angle which they subtend at the eye. As we go further and further away the image of the objects fall more and more towards the center of the eye with the result that the green object appears darker and darker in comparison with the red. Green and blue objects therefore fade out of sight, through loss of luminosity much more rapidly than red ones.

Gardeners know that, in order to produce a striking distant effect, red or orange flowers must be used. Blue flowers, however showy at close quarters, are no use for this purpose.

Owing to the yellow spot effect, too, it is quite possible that, while a violet light may illuminate a large white surface better than a red light, the contrary may be the case for very small surfaces.

We now come to what is really a very vital question and one about which there seems to be misunderstanding—the question what kind of light is best for revealing detail.

It has often been urged, and with some justice, that what we really require from a light is not so much ability to make objects appear bright, as ability to reveal detail. Nevertheless the opinions of the best authorities as to which colored light is really best for detail-revealing purposes vary very much. The question is really a very complex one. In the first case the action of the yellow spot will influence the problem. A black pattern on a red ground can be seen at a much greater distance than the same pattern on a green ground, simply because of the loss in luminosity of the green as the image falls more and more within the yellow spot. This can be very easily seen by drawing a similar pattern on red and green paper.

Close up the green will probably, if the surfaces are large, appear the brighter and therefore the pattern upon it the more distinct. But as one moves further and further away the green gets darker and darker so that its pattern becomes indistinguishable while the red can still be clearly seen. The colors of the paper should, of course, be as pure as possible.

From this point of view, then, there can be no question but that for illuminating objects to be distinguished at a distance, such as clocks, transparencies, and shop-signs, green and blue light would be much less satisfactory than red light.

But there is another and a more important factor which enters into the problem,—the fact that the eye is not achromatic. The result of this want of achromatism is shown in Fig. 3, which is taken from Tscherning's physiological optics.

Let A be a luminous point which sends the cone of light A, B, C, into

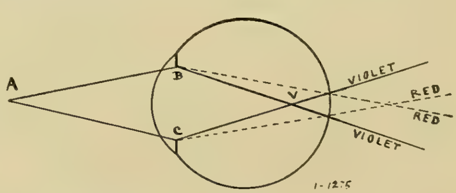


FIG. 3.—CHROMATIC ABERRATION OF THE EYE.

the eye. After refraction the violet rays are separated out and brought into focus at V, while the red rays are brought to a focus at R. Since sunlight and most artificial illuminants contain chiefly yellow light the retina of the eye commonly adjusts itself to yellow light and assumes a position midway between V and R.

When the eye is brought very close to a small luminous white object it becomes easier to accommodate for violet than for red light, and we usually see the white object surrounded by a red fringe. But when the eye is removed to a distance of, say, 10 feet from the object the state of things is reversed. It is difficult, however, to see the violet-blue fringe produced in this way because of its low luminosity.

But the effect is very clearly shown in the following way. Observe a naked glow lamp filament through cobolt glass—a glass which allows both blue and red rays to pass but obstructs the intermediate portion of the spectrum. When the eye is only a few inches away we see a purplish filament with a distinct red fringe.

But when the filament is observed from a distance of a few feet we see a reddish filament surrounded by a distinct ribbon of blue light. As the distance of the observer is still further increased this blue ribbon ultimately becomes a shapeless blue haze but the filament appears red. For the author's eye this happens at a distance of about 20 to 30 feet, but these results, are of course, modified by any optical defects that may be present in the observer's eye.

Now this property of the eye will clearly have an important influence on its power of observing detail, and the author has been making a series of tests with various acuteness of vision charts to investigate this point.

Briefly, it was found that, for a given illumination, red light reveals detail somewhat worse than white light and green light somewhat better —when the eye is close to the object viewed. This no doubt explains the fact, which has often been commented on, that for close work such as reading, the mercury vapor light is "restful" to the eyes, because the effort of accommodation is less.

But this condition of things was reversed when a chart was observed from a distance of 20 feet or more. Violet light, is particularly bad for this purpose, and an experiment of the author's with the Mercury vapor lamp shows this very clearly.

A series of lines were ruled with Indian ink on a sheet of drawing paper. This was illuminated by the mercury lamp. Now the chief luminosity in the spectrum of the mercury vapor lamp is located in three light bands in the yellow, green and blue-violet, respectively. Therefore, on looking at the sheet of paper through cobalt glass we utilize only the blue-violet light, but when viewing it through red glass only a very little yellow light comes through. It was found that the luminosity of the paper was incomparably greater for the violet than for the feeble yellow illumination. Nevertheless at a distance of about 4 to 5 feet the lines could be clearly seen with the yellow light, but were absolutely invisible by the violet light. Only when the eye was brought to about 18 inches from the paper could the lines be sharply focused.

To sum up, therefore, it appears that the blue-green end of the spectrum is somewhat advantageous for very close work, but very bad for the illumination of objects or patterns to be distinguished at a distance.

Moreover, for a short-sighted person this last difference is accentuated.

These results are particularly important, for it is evident that no amount of light will enable us to see an object distinctly by means of rays which the eye is unable to bring into sharp focus. Indeed, we might even succeed in getting better definition by interposing a suitable glass in front of the illuminant so as to cut off those rays which the eye is unable to focus, in spite of the reduction of illumination.

The color of a source of light may also prove to be of great importance when ability to penetrate a fog is desirable. The author has recently given his reasons for believing that red rays are the best for this purpose. It is to be noted that when people speak of the "penetrating" power of a light they often mean the distance at which it is visible to the eye. This, of course, introduces the physiological questions and makes the question more complicated. But both the "yellow spot" effect and the results of the want of achromation of the eye will also favor the red end of the spectrum.

On physiological grounds, one would suppose that the spectrum of our illuminants should be made as close to that of sunlight as possible. For countless generations our eyes have been adapted to the best use of sunlight, and it therefore seems possible that injurious results might follow the use of an excess of such colored light as red and violet, which we are only accustomed to receiving in a small quantity.

With this broad view of the subject most people would agree, but some difference of opinion seems to exist as to how the physiological influence of different portions of the spectrum really differs.

The influence of ultra-violet light on the eye is, however, now admitted to be dangerous. Most people who have worked much with arcs have, at some time suffered from inflammation of the eyes or burning of the skin, due to these rays. The author has met with a case when an ordinary arc was used for weeks without trouble, but the introduction of an iron core resulted in a light which soon set up retinal inflammation.

This was ascribed to the influence of the strong violet and ultra-violet element present in the iron spectrum. Snowblindness and the marking in cases of small pox are also now attributed to the ultra-violet rays, but they are probably influential in other ways not yet understood.

It is rather surprising, therefore, to find, in the ILLUMINATING ENGINEER for June of last year, a New York optician claiming the transparency of his glasses to ultra-violet light as an advantage, and the writer is quite in agreement with the editorial comments on the point. A London optician, on the other hand, recently went to the other extreme and recommended even normal sighted clients to wear flat glasses, constructed of glass which was opaque to ultra-violet light, in order to guard against the ultra-violet element in sunlight. This was, of course, absurd, but in view of the recent arrival of lamps for special purposes giving very powerful ultra-violet spectra, such as the Uviol lamp, the influence of these ultra-violet rays ought to be realized and guarded against.

A question on which there is much disagreement is, which are the rays in the visible spectrum which are the most "trying" to the eyes? There is a general impression, which the writer shares, that red colored light is, in some way, stimulating and irritating, while blue light is soothing.

It has been said that people living together in a room papered with light red wall paper soon become irritated

and quarrelsome, that the same influence is at work when the bull dislikes the red rag, when we choose red for our danger signal, and (until recently) red for the predominant color in war. The writer has been unable to find any scientific experiments to support the theory, however.

Dr. Steinmetz in a recent paper before the New York Section of the Illuminating Engineering Society suggested that red rays were more trying to the eyes on account of the fact that, in the case of artificial illuminants, the energy and therefore, also, the heating effect was greatest in this portion of the spectrum. He stated further that the pupil orifice contracts more readily in the case of red light than green in order to shut out this heat energy.

While feeling a little natural diffidence in questioning the results of such an authority as Dr. Steinmetz, the author's own experiments have quite failed to confirm this fact. In conjunction with Mr. Val. Mackinney, at the Central Technical College, the writer has made some experiments on the influence of red and green light on the pupil orifice, and quite failed to obtain any marked difference in its behavior with respect to these two colors.

The effect of heat energy on the retina was also tested in the following way: A glow lamp was painted dead black; and was then considerably overrun, so that it became too hot to touch. It was then found that this lamp could be brought uncomfortably near the eye so as to produce a heating effect immeasurably greater than that produced by the rays of any illuminant without causing any perceptible contraction of the pupil orifice—indeed, in the case of one observer a perceptible opening of the orifice was observed.

Whether the apparent exciting effect of red light is due to the presence of additional heat-energy or no, therefore, the author is unable to find support for the theory in the behavior of the pupil orifice.

Finally there will certainly occur particular cases in illumination where particular effects can be received by the use of light of a particular color. No one could recommend a mercury vapor lamp for the tempting display of meat, for instance, but the red flame carbons of Siemens might have the effect of accentuating its tempting appearance. Drapery and millinery stores should certainly be lighted by an illuminant approaching daylight as nearly as possible, in spectral composition, while diamonds, which owe their sparkle to their high dispersive power, should also be illuminated by white light.

It is also worth noting that a peculiar shade of color is probably much more effectual in "drawing the eye," and attracting customers, than the concentration of extremely bright illumination in a small space, which is commonly supposed to achieve this object.

Judgments of Color

By Dr. Louis Bell.

It is not the writer's purpose here to take up the manifold difficulties of color photometry, but merely to consider some of the common errors which result from considerations of color. To begin with, the human eye has but a poor memory either of color, or of intensity, as every one who attempts to match colors from memory has discovered. Nor is there any general agreement as to what shall be called white, so that comparisons of color, unless made under exactly similar conditions, may have very little significance. If one could compare colors as seen in the light of a north window with the same colors as seen by the light of a late afternoon sun the result would be somewhat startling. For the light of the sky is very rich in blue rays, as its hue in the sky suggests. Of the total light in a sunny day some fifteen to twenty per cent. is suffused sky light scattered from finely divided matter suspended in the air. Lacking such action, the sky itself would be black and every sunless room an abyss of darkness. Therefore, daylight as we know it even in full sunshine has a bluish cast compared with sunlight itself, and diffused daylight by itself is quite strongly blue. Hence the blue shadows on snow as compared with the warm hue of the sunlight, the contrast being heightened by the effects of simultaneous contrast.

These peculiarities of daylight must be borne in mind in the every day work of illumination. Take for example, the apparently simple question of determining the interior finish of a room. It is entirely possible to find tints which will do admirably in diffused daylight, but which will lead to complete failure in artificial light. A good type of this action may be found in a light shade of blue. A room papered in such a tint will be light and pleasant in diffused daylight, but when the gas is turned on there is trouble at once. For equal intensities in the red skylight has some twenty-five times as much blue and violet as does gaslight. The blue paper kills the red by selective reflection, and the gaslight has no blue to speak of anyhow so that the net result is almost entire absence of help from the walls in spite of their apparently light tint. On the other hand, deep reds and greens are of very low luminosity as diffusive surfaces, and although selectively they are not bad they still kill the incident light most effectively, and many a man has had his gas bill doubled by employing them too freely. A deeply colored paper may have a fairly high coefficient of diffuse reflection for a particular color, but if that color is of low luminosity this reflection is of no practical value. For example, a certain clear blue has a coefficient of fully 70% for the blue and violet, but the actual luminosity of the region involved being only perhaps 5%, the selective action is practically worthless. The moral of all this is that colors for interior finish, when artificial lighting is a matter of importance, should be tried by the illuminant it is intended to use, for a daylight comparison, unless made by an expert in illumination, is likely to be very deceptive.

Akin to the errors in judgment involved in passing from natural to artificial light are those produced by what one may call mass effects in color. These occur with both natural and artificial light, and are prolific sources of annoyance and of litigation.

Many a painter has been fervently cursed on their account, and many a wall paper condemned and soon replaced. The whole thing is so simple that it hardly needs explanation, and yet people in general persist in forgetting about it. Any interior illumination is the sum of that received direct from the radiant and that diffusedly reflected once or many times from the walls. Therefore, the average color value is determined by the sum of these elements, and since at each reflection from a colored surface the favored color is relatively intensified the more a particular color occupies an interior the more intense it becomes and the deeper in tone. A small sample of paint or paper is then an entirely fallacious guide as to the effect which will be produced. En masse the color grows stronger and more pervading and the sample which looks just right may prove dark and muddy when in place. The ceiling color likewise is an important element in the general result. If this be white, all the color tones of the walls lighten, same as they are influenced by simultaneous contrast, while a dark ceiling plays its own part in the general effect. Striking changes in color tone, such as appear in fabrics under artificial light, seldom are found in interior finish, most pigments showing general absorption over a considerable range of the spectrum without sharply defined absorption bands. But the general effects are nevertheless very marked, and their inter-relation is sometimes most deceptive. It is, therefore, unsafe to trust a generalized judgment, but so far as possible one should try to test out the working color combinations in somewhere nearly the relations in which they are to be practically employed.

The Alternating Arc and Talbot's Law

By John C. Shedd.

In 1834 Talbot gave the law that has since gone by his name. This law received careful consideration by Helmholz and was by him expressed as follows: "If any part of the retina is excited with intermittent light, recurring periodically and regularly in the same way, and if the period is sufficiently short, a continuous impression will result, which is the same as that which would result if the total light received during each period were uniformly distributed throughout the whole period."

It is of course apparent that the A. C. arc is in reality a succession of light flashes emitted (in a 60 cycle circuit) at the rate of 120 per second. It has also been experimentally shown that each flash is separated from its neighbor by an appreciable interval of time, so that there is not merely a dimming down of the light but a practical extinction of all light.

That this should result in a diminution in the total light-flux is apparent, and Talbot's law enables us to very approximately evaluate the loss in light-flux and in intensity due to this cause.

In the first place it may be assumed that during the light-giving period the light is of the same candle-power as the direct current arc taking the same energy. This assumption leaves something to be desired in point of

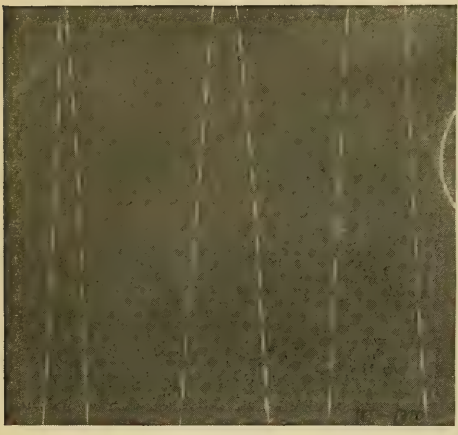


FIG. 1.—PHOTOGRAPH OF A. C. ARC TAKEN WITH MOVING CAMERA.

accuracy, since a given amount of energy applied at a uniform rate to one carbon tip must result in a larger luminous surface than the same energy applied intermittently to both carbon tips.

Having made the above assumption it remains to determine the ratio of the light periods to the dark periods. This may be readily done by photographing the A. C. arc by means of a moving camera. Fig. 1 was secured in this way from a street arc lamp. Measurements of this plate under a low power micrometer-microscope gives the ratio of 70% light to 30% dark; that is to say, the light flashes

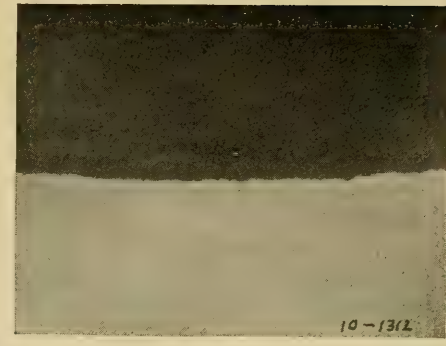


FIG. 3.—FIELD OF LANTERN SHOWING DISK STATIONARY.

last for 70% of each cycle, and for 30% of the cycle there is no light.

The results of the foregoing may be very strikingly shown to an audience by means of the lantern. A disk, shown in Fig. 2, is mounted on a small electric motor and placed in the focal plane of the lantern, as shown in Fig. 3. The effect of rotating the disk will be to illuminate part of the field by intermittent flashes, while the rest of the field is illuminated by continuous light of the same intrinsic brightness. Fig. 4 shows the field of the lantern when the disk is rotated at a high rate of speed. The shadowed part of the field receives 30% less light than the clear portion.

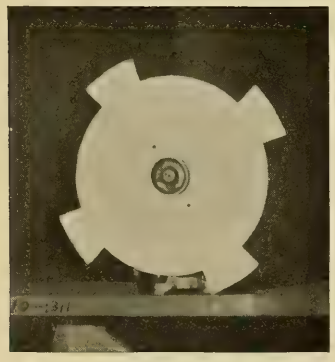


FIG. 2.—DISK MOUNTED ON AN ELECTRIC MOTOR: TEETH, 27°; OPEN SPACES, 63°.

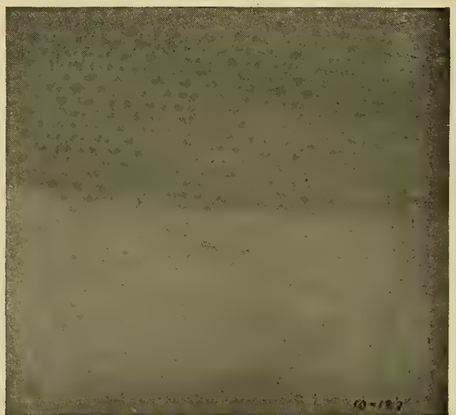


FIG. 4.—FIELD OF LANTERN DISK ROTATING AT HIGH SPEED.

Research and Investigation

Conducted by

THE ILLUMINATING ENGINEER

The Influence of Chimneys Upon the Efficiency and Performance of Incandescent Gas Burners

II. Effect of Varying Gas Pressure

In our January issue we give the results of tests made upon the several different styles of chimneys in most common use, with a gas pressure of 1.5 inches, and stated that the test would be continued for other pressures. Reports of such tests are as follows:

REPORT ON PHOTOMETRIC TEST OF WELSBACH LAMP WITH VARIOUS CHIMNEYS, CONDUCTED FOR THE ILLUMINATING ENGINEERING PUBLISHING COMPANY.
ORDER NO. 2695.

This test is a continuation of those recorded in report No. 2655, as published in the January, 1907, issue of THE ILLUMINATING ENGINEER. The burner, mantle and chimneys are those used in preceding tests and are of the following description:

Description.

Welsbach gallery burner, catalog No. 66, with No. 66 deck plate.
No. 197-J mantles (new).
Clear glass chimneys of the "F. Q. M." brand, as follows:

TABLE III.

Fig. No.	Style.	Height.	Max. Diam.
1	Plain	5⅞ in.	1 15/16 in.
2	Plain	8 "	1 15/16 "
3	Airhole	5¼ "	2¼ "
4	Airhole	6¾ "	2⅜ "
5	Airhole	9⅞ "	2⅞ "

METHOD OF TEST.

As the photometric test was calculated to yield only comparative results, only the mean horizontal candle-power was measured. At the beginning of the test two gasometers were filled with ordinary New York City gas. These, suitably loaded, delivered the gas to the burner at any desired pressure. Two tests were made: the first with gas supplied to the lamp at a pressure of 3 inches water. Under this condition the burner was equipped with each of the five chimneys in turn, and the candle-power was measured with various adjustments of the gas flow at the burner, ranging from the smallest supply of gas which would render the mantle fairly incandescent, up to the maximum supply of gas which could be used with satisfactory results. In the second test the burner was adjusted with each chimney so as to yield maximum candle-power at a pressure of 2¼ inches water (a pressure midway between those adopted for the two other tests). With this adjustment gas was supplied to the burner under various pressures, ranging from ½ inch to about 4½ inches water.

RESULTS OF TEST.

The continuous line curves in Fig. 4 show diagrammatically the candle-power and the efficiency (expressed in candle-power per cubic foot per hour) of the lamp when equipped with each

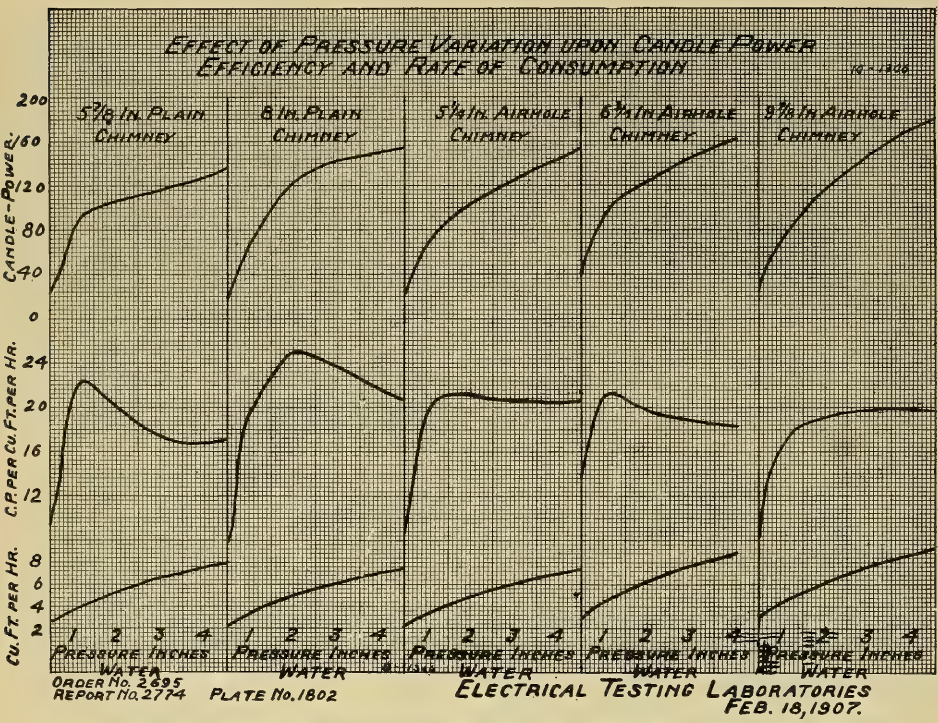


FIG. 4.—CURVE SHOWING CANDLE-POWERS AND EFFICIENCIES OF DIFFERENT CHIMNEYS.

of the five chimneys and when consuming gas at various rates, supplied at a pressure of 3 inches water. The broken line curves show the results as previously reported for the similar tests with gas supplied at a pressure of 1½ inches water.

The following table shows the maximum candle-power value obtained with each chimney, and the corresponding gas consumption and efficiency. It also shows the maximum efficiency obtained with each chimney, with corresponding candle-power and consumption values. For purposes of comparison, the results of the previous test made with gas supplied at a pressure of 1½ inches water are shown.

Fig. 5 shows diagrammatically the results of the test with fixed burner

Chimney.	Max. C.P.		Consumption. (Cu. Ft. per Hr.)		Efficiency. (C.P. per Cu. Ft. per Hr.)	
	½" P.	3" P.	1½" P.	3" P.	1½" P.	3" P.
Maximum Candle-power Basis.						
5⅞" straight	98	117	4.25	6.0	23.0	19.5
8" straight	103	134	4.75	6.2	21.7	22.4
5¼" airhole	107	134	5.45	7.0	19.6	19.2
6¾" airhole	121	150	5.95	7.5	20.3	20.0
9⅞" airhole	128	158	6.75	7.8	19.0	20.5
Maximum Efficiency Basis.						
5⅞" straight	96	106	4.0	4.7	24.0	22.4
8" straight	92	121	3.9	5.0	23.7	24.0
5¼" airhole	91	120	4.25	5.6	21.9	21.3
6¾" airhole	118	135	5.5	6.2	21.5	21.7
9⅞" airhole	117	151	5.5	7.0	21.3	21.6

TABLE IV.

FIG. 5.—EFFECT OF PRESSURE VARIATION UPON CANDLE-POWER, EFFICIENCY AND GAS CONSUMPTION.

adjustment and varied gas pressure. This diagram shows candle-power, gas consumption and efficiency. The following table is derived from the curves and shows the maximum candle-power obtained from the lamp equipped with each chimney in turn, when the burner was adjusted as stated. Consumption and efficiency values also appear. The same table shows the maximum efficiency obtained with each chimney under this particular set of conditions, and the corresponding candle-power and consumption values.

This test is of value chiefly as affording comparative results. Because of the many variables which affect the performance of a mantle burner, the quantitative interpretation of the data

Chimney.	Max. C.P.	Efficiency. (C.P. per Cu. Ft. per Hr.)	Consumption. (Cu. Ft. per Hr.)	Pressure. (Inches Water.)
	Maximum Candle-power Basis.			
5⅞″ straight	136	17.1	8.0	4½
8″ straight	154	20.7	7.3	4½
5¼″ airhole	154	20.7	7.3	4½
6¾″ airhole	162	18.3	8.9	4.0
9⅞″ airhole	180	19.6	9.2	4½
	Maximum Efficiency Basis.			
5⅞″ straight	95	22.4	4.0	1¼
8″ straight	123	25.1	5.0	2
5¼″ airhole	90 to 104	21.2	4.3 to 4.9	1½ to 2
6¾″ airhole	105	21.3	4.9	1¼
9⅞″ airhole	153 to 175	19.7	7.9 to 8.9	3.2 to 4.2

TABLE V.

given must be subject to the limitations imposed by a single set of conditions.

PRESTON S. MILLAR,
In Charge of Test.

Approved by
CLAYTON H. SHARP,
Test Officer.

power, and, therefore, are rarely used at maximum efficiency.

Fourth: Increasing the pressure increases the candle-power with all chimneys, but beyond a certain point decreases the efficiency.

The arrangement of results in the following tables give more detailed data on the above points:

RELATIVE GAS CONSUMPTION ON BASIS OF EQUAL CANDLE-POWER, ASSUMING ADJUSTMENT FOR MAXIMUM CANDLE-POWER.

Chimney.	1½″ Pressure.	3″ Pressure.
5⅞″ Plain	82%	104%
8″ Plain	87%	94%
5¼″ Airhole ..	96%	106%
6¾″ Airhole ..	93%	101%
9⅞″ Airhole ..	100%	100%

RELATIVE GAS CONSUMPTION ON BASIS OF EQUAL CANDLE-POWER, ASSUMING ADJUSTMENT FOR MAXIMUM EFFICIENCY.

Chimney.	1½″ Pressure.	3″ Pressure.
5⅞″ Plain	100%	107%
8″ Plain	102%	100%
5¼″ Airhole ..	112%	113%
6¾″ Airhole ..	112%	111%
9⅞″ Airhole ..	113%	112%

An examination of the foregoing tests shows that the results obtained under higher pressures are of the same general order as those formerly reported. The following general facts seem, therefore, to be fully established:

First: For pressures under 1½ inches the short chimney gives the highest efficiency; for pressures from 1½ to 4 inches the 8-inch plain chimney gives the highest efficiency;

Second: The greatest candle-power is obtained with the tallest air-hole chimney;

Third: A burner adjusted to give maximum candle-power with any given chimney does not work at its highest efficiency, and *vice versa*. In the adjustment of a burner, therefore, either candle-power or efficiency must be sacrificed. As the consumer has no means of adjusting to maximum efficiency, burners are practically always adjusted to maximum candle-power, and, therefore, are rarely used at maximum efficiency.

To illustrate the foregoing conclusions by a practical example: Assuming that a building is lighted by gas supplied at a pressure of 1½ inches, the highest candle-power will be obtained by the use of 10-inch air-hole chimneys, assuming that the lamps are adjusted in the usual manner to maximum candle-power. If these chimneys were replaced with 6-inch plain chimneys, and sufficient additional lamps used to produce an equal total quantity of light, the illumination would be obtained with 18% less gas. If the gas were supplied at 3 inches pressure, the highest candle-power would be obtained as before with the 10-inch air-hole chimney, but an equal amount of illumination could be obtained with the 8-inch plain chimney with 6% less gas.

There still remains to be investigated the effect of shape and the matter of air-holes, upon which reports will be made later.

Editorial

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Our First Birthday

With this issue, THE ILLUMINATING ENGINEER begins the second year of its existence; and the occasion of its first birthday may offer a sufficient excuse for retrospection and reminiscence.

In general, we feel very much gratified at the results of the first year's work. Although the magazine has been but one year before the public, it should really be counted as ten years old, for it was at least nine years old when it was born. The idea of establishing such a publication was conceived by the present Editor as far back as 1897, and was never entirely lost sight of from that date until it materialized a year ago. The idea was occasionally divulged to friends who were interested in matters of lighting, but was invariably met by the query: "Where can you get matter to fill up the pages?" While none would deny that the subject of illumination might furnish material for a book, there was no one, with but a single exception, who fully realized that illuminating engineering is a progressive science and art, and that consequently any treatment of the subject which should be up-to-date must be in serial form. When at last the publication was definitely decided upon, and work actually begun, it was found by coincidence that the first move had been made toward establishing an association of those interested in the same subject. The simultaneous appearance of THE ILLUMINATING ENGINEER, and the Illuminating Engineering Society lead some to believe that the two had some official connection. Such, however, is not the case; they were merely coincident, although the original idea of the publication was many years older than the conception of the Society.

A glance at the last page of Volume I (which is 1084), is sufficient to show how little those who had questioned the possibility of securing sufficient material, understood the extent and importance of the subject, and the rapidity of its growth and development. When upon further examination of its pages, it is seen that the type used is set "solid," and that all reprinted matter is in a smaller size type than that commonly used in technical publications, the scepticism of the "doubting Thomas's" is shown to be still wider of the mark. Furthermore, this subject matter all has a di-

rect bearing upon the various questions involved in illuminating engineering, the purely commercial and advertising elements being wholly eliminated.

We must admit that the general interest in the subject, as shown by articles in the technical press, and papers before the various scientific societies, outstripped even our own expectations; but we started with the intention of making this publication a complete source of information, giving at least a digest of all matters pertaining to the subject appearing in the literature of the world, as well as original contributions from those most competent to write upon the subject; the extent to which this has been accomplished we must leave to the judgment of our readers. It is doubtful if any technical periodical has ever published in its first volume an amount equal either in quantity or quality to that contained in Volume I of THE ILLUMINATING ENGINEER.

The numerous expressions of appreciation from subscribers, as well as the very generous subscription roll that has been accorded us, are most gratifying evidences that our efforts have been appreciated. The amount of matter on subjects pertaining to illumination appearing in the technical, and even the literary press of the world, as well as in the proceedings of scientific societies, necessitates a continuously close editing and digesting in order to reduce it to the available space; but it is our intention to at least make such reference to all articles as to enable the reader to judge whether the entire text would be of interest to him. We have also given particular attention to securing the cooperation of the various authorities on the different subjects included in the science, and are pleased to announce that special contributions will appear in the various issues of the coming year.

Illuminating engineering admittedly has an aesthetic, as well as a purely practical basis, and in conformity with this fact, it is our aim to give the magazine a due share of artistic treatment, and such mechanical execution as will put it on a par with the most artistic treatment of illuminating engineering problems.

We take this occasion to acknowledge the generous support of the public, and to solicit its further patronage, which we shall use our best efforts to deserve by actual merit.

The Relation of the Technical Journal to Commercialism

Americans are pre-eminently and admittedly a commercial people. To quote Emerson, "they ask first of any project, Will it bake bread?" Or, to paraphrase the sentiment in the vernacular of the day, "Will it raise dough?" As the Frenchman "looks for the woman in the case," so the American looks for the "graft." No matter how ostensibly a new project may be devoted to science, literature, or humanity, the presumption is that somewhere hidden in the background is a scheme of financial agrandisement. This feeling attaches not only to the newspaper press, but even to technical and scientific journals. There is no denying that this natural scepticism of the public as to the ingenuousness of both news and scientific items is not without reason. The glowing account of the new scientific discovery often ends with an exhortation to take Dr. Buncomb's pills, or to use Scrub's Soap; and the wary reader often begins at the last paragraph in order to ascertain whether or not he is to meet this anti-climax.

The fact is deplorable for two reasons; first, because it retards the ad-

vancement of real scientific progress by casting doubt upon the actual results of research; and second, because it casts equal doubt upon the real merits of new and improved articles of manufacture.

The word "commercialism" has acquired a sinister meaning, implying a mere greed for dollars, with a corresponding disdain for purely scientific or theoretical research. This is unfortunate. Science and commercialism are two equally important elements of progress. Science comes first in the natural order of things, since the facts and laws must be discovered before they can be commercially utilized. Properly speaking, commercialism is merely the application of the work of the investigator to its beneficient use of benefiting mankind in general. Tyndall once said that as soon as he had developed a discovery to the point where it could make money, he immediately dropped it, being sure that there would be plenty of others to take it up and develop it from that point on. His observation was both philosophical and just. The work of the investigator and student of pure science, measured by its benefit to humanity, is of equal, but not superior importance, to the work of the financier or practical manufacturer who makes it possible for society to become beneficiaries of the investigators' work. When the investigator or inventor has made the new discovery or designed the new machine the work has only been half done; it remains for the commercial engineer to reduce the discovery or invention to a practical form, to organize a propaganda for spreading the merits of the improvement among the masses of the people, and to place it physically within their reach. Without this labor of the commercial engineer, the most revolutionary invention would remain a mere record of the flights of inventive genius. Pure science has, therefore, no license to despise what it may scornfully term "commercialism."

The technical journal, whose particular province it is to promote all progress in the particular field which it may cover, must therefore not only treat the commercial side of science, but is in duty bound to do so as much as the purely scientific side. The manufacturer who has seriously and conscientiously worked to improve any given article, and has succeeded in doing so, is quite as worthy of praise for his effort as is the theorist or inventor who unearths some new principle. In giving such credit and exposition of the practical and commercial side of progress, however, one condition must be strictly observed, namely; the subject must be treated with the same scrupulous respect for fact, and with the same impartiality of opinion that is used in the treatment of purely scientific questions. The manufacturer who seeks to make genuine improvements, and at least in his own honest opinion, puts forth the best that it is possible for him to produce, need have no fear of criticism; in fact, the more impartial and rigid the investigation the more the results will redound to his credit. A careful distinction, moreover, must always be made between mere claims, even though they may be honestly put forth, and incontrovertible facts established by experience and test.

It has long been the practice in technical journalism in this country to devote a certain amount of space to the commercial exploitation of various articles, besides the space used in the purely advertising columns. Such articles have been commonly classed under the title of the "write-up." As even the most unsophisticated layman knows, these "write-ups" are almost

invariably the work of the advertising or publicity department of the business house from which they emanate. Sometimes they are collected in a single division of the periodical; in other cases they are more or less scattered through the text. We have always considered these both useless to the manufacturer and a reflection upon the intelligence of the reader, and altogether out of place in a technical journal. It may be well at this point to distinguish between the technical and the trade journal. The former deals with the various scientific and practical problems in connection with the production and use of some particular line of manufacture, while a trade journal is properly confined to the commercial department; that is, the manufacture, sale and distribution of a particular line of merchandise.

As we have attempted to set forth, we believe that the manufacturer is entitled to a full and unstinted measure of credit for actual improvements that he may make in any department of manufacture or commerce; but this recognition should come from an independent observer or user. We recall in the early days of the bicycle industry that certain manufacturers published in their advertising matter opinions from different users as to the merits of their product. A certain manufacturer, who had the "saving grace of humor" highly developed, followed the custom, starting out with a glowing testimonial as to his own ability—*written by his mother.* We cannot recall a keener or more philosophical bit of sarcasm. It is conceivable that one might obtain a fair description of a child's character from its mother, but that assuredly is not the source from which one would naturally seek an unbiased opinion; and the fullsome praise of the parent does not ordinarily create any deep or lasting impression as to the real character of the child. The self-lauditory "write-up" is in precisely the same category.

We believe, therefore, that this time-worn custom is much more honored in the breach than in the observance. If a manufacturer really has an article of merit, or has made an improvement that is actually a step in advance, even though of minor importance, he commits a double fault by insisting upon the insertion of a "write-up"; he either fails to make any impression at all, or gives the impression that he is simply "blowing his own horn," and at the same time misses an opportunity of having the real progress that he has made, or the actual merits of his goods, convincingly, though conservatively, proclaimed by a disinterested and impartial judge.

The Illuminating Engineer will, therefore, continue, as in the past, to set its face against the traditional "write-up." It will, however, seek to keep posted on the latest improvements and general progress in the domain of illumination, and whatever is found worthy of commendation will be given its full share of attention; and this will be done absolutely irrespective of any advertising in the present or in prospect. In order that we may keep our readers posted in the line of material progress, we cordially invite manufacturers and experimenters to send in all information possible along the line of development and improvement in which they are especially interested.

In conclusion, it is only fair to state that we are not in the business of "muck-raking"; we simply wish to follow the maxim, "honor to whom honor is due," believing absolutely in the survival of the fittest, and that the best will win as soon as its merits become known to the public. Except in cases

of self-evident fraudulent intent, we do not consider it the province of the technical journal to criticise or make odious comparisons; the inferior article will naturally die of inanition. It is only necessary that the public know what is superior; and it will always find out in the end, in spite of the most vigorous and specious "publicity" campaign that the inferior can carry out.

"Who Shall Decide When Doctors Disagree?"

The discussion of the papers at the last meeting of the New York section of The Illuminating Engineering Society, brings this old and oft repeated question again into view. There was not a single important principle enunciated by one member that was not flatly denied by some other member. This state of affairs must suggest to the layman one of two things: either those calling themselves illuminating engineers have not yet agreed upon the fundamentals of the science, or these fundamentals are merely matters of opinion, and therefore Illuminating Engineering so-called has no solid scientific basis.

Although the full acceptance of either of these conclusions would be erroneous, it must be admitted that each contains some measure of truth. Science has been briefly defined as classified knowledge; and before any particular department or branch of knowledge can rightly claim to be science, a sufficient number of co-related facts must have been determined, and established as true, to afford a basis of logical classification. The established and accepted facts in regard to matters of illumination are still comparatively meager, so that on many points of fundamental importance the requisite data is not yet sufficient to afford a basis for positive generalizations. The collection of such data is, however, proceeding at a constantly increasing rate, so that this deficiency will be removed at no very far distant date.

That many of the views expressed are more largely matters of personal opinion than of scientific fact, there can also be no doubt. Personal opinions are invariably more or less influenced by the particular conditions and circumstances under which they are formed. This unconscious leaning toward some particular view makes up what is usually signified by the word "prejudice"; and it is a notorious fact that prejudice lives longer and dies harder than any other thing in existence. Most of those interested in Illuminating Engineering at the present time have taken up the subject primarily for commercial reasons from having been interested more or less in the development of some of the practical means of producing or utilizing artificial light; and it would be as contrary to all natural laws for one not to have a strong predilection in favor of the particular device which he had been instrumental in developing as it would be for a father to depreciate the peculiar abilities of his favorite child. This fact was peculiarly in evidence in the discussion referred to. The speaker whose work had been principally with arc lights was horrified at the idea of illuminating large spaces with numerous small units. Another who was interested in developing a system which can only produce general illumination could see nothing but faults in special illumination. One considered indirect lighting as the most nearly perfect, while another pointed out its exceedingly harmful effect on the eyes; and so on to the end of the chapter.

The various opinions expressed remind one of the old definition in the-

ology that orthodoxy is my-doxy, and heterodoxy is your-doxy. Apparently if all the illuminating engineers could have their way each would be busy tearing out the work of the other. This is an unseemly condition of affairs; and unless more serious efforts are made to arrive at the actual truth, and to determine without prejudice what is better, and, if possible, what is best, must seriously retard the acceptance by the general public of illuminating engineering as a science.

Illuminating engineering is an art, as well as a science, being somewhat analogous to architecture in this respect. This means that, to a certain extent, its practice involves judgment and taste, as well as the mere use of formulæ. On such matters, therefore, it is impossible to say that one opinion is right and another wrong. There are many minor points in which the desired effect may be produced in a number of different ways; but unless there are certain fundamental principles, which can be established as facts, illuminating engineering can lay no claim to being a science. We believe that there are such fundamental principles, and that they are susceptible of as positive proof as the principles of many other branches of science.

As a science, illuminating engineering must be largely deductive, *i. e.*, its general laws must be deducted from the observation of a large number of special cases, and the probable truth of the generalization will depend upon the number of special cases observed. Thus, a general law deduced from two observations is useless, as it is as likely to be false, as true; but as the number of observations increases, the probability of the truth of the deduction increases. It cannot, therefore, be expected that the principles of illuminating engineering which must depend upon such deductions can be established upon a reasonably certain basis until a sufficient number of observations have been made to give a reasonable probability of their truth; but that certain fundamental laws can be established in this manner is sufficiently apparent to all who have investigated the subject. As a single instance, take the subject of the so-called indirect method of lighting, on which there seems to be radical differences of opinion; either this method is the best hygienically, or it is not; and the question is not one of theory to be worked out inductively, but a question to be decided solely by observation and experiment. The limit of intensity that may be properly used for various purposes is another question susceptible of fairly definite determination. The hygienic effect of the various colors of artificial light is a similar problem; and there are numerous others equally susceptible of experimental proof.

On questions of opinion everyone is not only entitled to hold his own, but to do as much as he pleases to discredit the opinions of others; but on matters susceptible of proof, it is the part of wisdom and discretion to reserve judgment until sufficient evidence is presented upon which to form a reasonable conclusion.

Some have claimed that there is such a thing as "honest graft"; but whether this be true, or not, there may certainly be "honest prejudice," and it is not only natural, but absolutely right, that the experimentor or inventor should thoroughly believe in the particular apparatus or processes which he is developing. To the consumer, however, all new schemes and inventions look alike; and in order that he may get the full advantage of all, he may properly employ an expert who has made a special study of the whole field from an intelligent view-

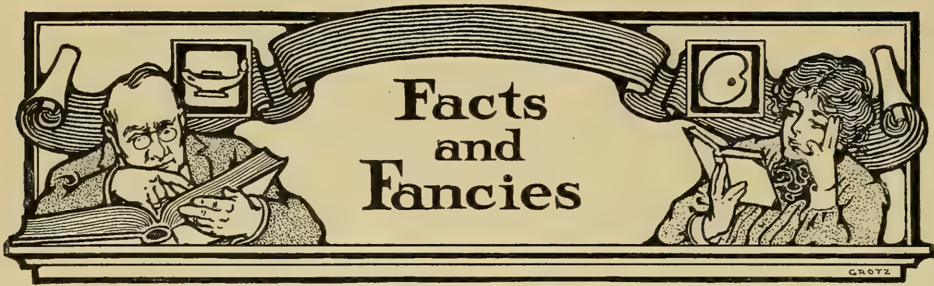
point, and who, having no interest in any particular one, is capable of passing impartial judgment.

"The services of a competent engineer," as Stephenson remarked, "are not an expense, but an economy"; but the consumer, in seeking such an engineer, will look with equal scepticism on "honest graft" and "honest prejudice," and will give both as wide a berth as possible. If the illuminating engineer is to be worthy of his title—and his fee, he must keep free alike of prejudice, and of substituting his personal preferences and opinions for facts established by experiment and research.

Colored Globes and Shades

In one of the papers presented at the last meeting of the New York Section of the Illuminating Engineering Society, the matter of modifying the color of the incandescent gas light was dwelt upon, and elicited considerable discussion. The author of the paper stated that he had found an amber glass globe which gave a very mellow and desirable tone to the light, and only absorbed thirty-five per cent. This announcement was generally received with approval. The desirability of removing the slightly greenish hue of the incandescent gas light has long been recognized; and inasmuch as an almost perfect globe for this purpose was put upon the market some eight years ago, as stated by one member in the discussion, it is a somewhat curious fact to find the matter now brought forward with all the enthusiasm of original discovery. Amber, however, is not the most desirable color to use for this purpose. As stated, the objectionable tone of the light is due to a slight excess of green rays; and in order to suppress these a glass of the complimentary color must be used, namely, some shade of red. The globes mentioned as having been put upon the market some years ago were of a salmon pink tint, which fulfilled this condition perfectly, giving the transmitted light from the incandescent mantle a color indistinguishable from that of the gas flame or electric lamp. Even though it has been overlooked for a time, the reopening of this subject of securing a more pleasing color of illumination from incandescent gas burners, without a prohibitive loss in efficiency, is to be welcomed as a step in the right direction.

A still more curious observation was that of one of the members, that with the new high-efficiency lamps that are about to come into use, and which give a comparatively white light, the use of tinted globes will be desirable to tone down this whiteness. After all the years of experiment and research to produce artificial light that shall approximate sun light in color, and having achieved at last the long-sought light, we must now turn our attention to discovering a means of giving this light the lurid hue of the pine-knot torch of the cave-dweller! No wonder the poor layman fails to appreciate the intricacies of the "Science and Art of Illumination."



Birds as Illuminating Engineers

The writer confesses to having some distinct recollections of the last total solar eclipse visible in this latitude, which occurred in 1869. The two facts which are most clear in his recollection are the uncanny reddish hue that the whole landscape took on as the suns disc was gradually shut out from view, and that fact that, by the time the eclipse had become total, all the chickens had gone to roost! As this occured, to the best of his recollection, at about four o'clock in the afternoon, or more than two hours before the time for sun-set, it is evident tnat the chickens gaged their retiring time by the approach of dusk, quite regardless of the time of day at which this occurred.

From the following incident noted in the "Electrical Review," it appears also that birds are quite as willing to postpone their retiring time if the day can be lengthened out by artificial illumination. The "Review" says:

The mortality of some tropical birds of long natural life in the aviaries of zoological gardens has long been a problem in such institutions.

The efforts to maintain the natural temperatures and even humidity which prevail in the tropical regions forming their habitats, and to provide their natural foods, have proved futile as to the results.

Another cause for this difficulty has been found to lie in the feeding habits of the birds, which are based on the approximately equal divisions of day and night prevailing throughout the tropics.

It appears that it has been found from the observations of explorers that in the tropics many of these birds wake at sunrise and obtain their food, and also feed again before sunset.

The long nights of Winter in the Northern climates deprive these birds in captivity of their food for an unnaturally long time, and this condition has been relieved in a certain zoological garden where the portions of the aviary containing such tropical birds are lighted by electricity at six o'clock in the morning, when the birds awaken and feed. The lights are turned on again in the afternoon and these quarters are as daylight until six o'clock in the evening.

After all, the old-time query as to whether the crowing of the chanticleer at sunrise is due to instinct or to observation, leads to some interesting parallelisms in the questions of conditions of bird life.

A New Use for Remnants of Arc Light Carbons

By G. W. Pearce.

A down-town janitor is doing a large and rapidly increasing business in selling fragments of arc light carbons as sovereign remedies for rheumatism, neuralgia, and *la grippe*. In a number of circles of Afro-American society in the Boroughs of Manhattan and Brooklyn, this janitor has long been accounted a bright and shining light in the arts of electricity, on account of the fact that he was for a long time a messenger of a distinguished electrical engineer, now and for a long time past an official in the engineering department of this city. Time was when this engineer was the promoter of a lighting plant under construction in a southern city; to whom

came one day a small colored boy who asked for a job. He was put on as errand boy, and was afterward used as a general utility hand in various lighting plant building operations all over the southern states.

During the building of one plant at a time of hard gales in the financial market, the promoters of the undertaking suddenly came to the end of their resources; payday after payday passed without a sign of money. The engineers economised by building a shack and chipping into a common fund for living expenses. John, the colored boy, then grown to early manhood, was made chief commissary and cook. The food was good, everything in John's department was well done, and received merited praise from the engineers.

But John's expenditures were so small for supplies, that when the hard times in the money market blew over, and money came along the line in bountiful showers, the engineers voted economy not the thing and went back to live at the best hotels in the vicinity. Then it was that John was brought before the auditing committee to receive a present of cash, and to explain how it was that he had kept living expenses down to lower figures than had been thought possible. John opened his heart and said that "he had reckoned that times were going to be worse than they had turned out," and for that reason he had spent most of his night hours going the rounds of the country stealing chickens, eggs, butter, fruits and vegetables, and at other times he had ingratiated himself into the affections of several colored housemaids to the end of obtaining from them, tea, coffee, sugar, spices, and about everything else of use in a well regulated kitchen, without money and without price. Lectured on the enormity of these offences, and exhorted to make restitution, John rolled on the floor with glee, and declared that there was nothing wrong in what he had done, and if he had not taken the stuff some "low down common nigger, what knowed nuthin' 'bout waitin' on electric gentlemen, would have helped himself to what was layin' 'round loose, and would have jollied the colored ladies out of their massa's groceries."

When the engineers returned north, John went with them. Married long ago to one of the colored ladies who met with his approval in plant-building days in Dixie, he has a large family of children, all of whom are named from a well considered plan of taking names from a dictionary of electrical terms—with such "improvements to the names as make 'em sound like poetry," says John. His first-born, a girl, is named Volta; the second olive branch, a boy, is named Amperdon; then came twins, who, in obedience to a suggestion from an engineer of one of the largest illuminating plants in Brooklyn, were named Rheostati and Multipolaris.

Some time ago, thanks to the interest of his old friends in electrical engineering, John was made the janitor of a fine building. All went well until a few days ago, when his employers suspected, by numerous evidences of John's increased intakes of money, that he must be making illicit commissions on supplies furnished to the building. An investigation revealed that nothing of the kind was going on. Then John was called to the office and asked to explain why it was that he was spending much more money than he earned as a janitor. He then gave an account of his business in selling bits of carbon pencils as sure cures for rheumatism, and he presented an armful of letters from persons the country over, declaring that they had been

cured of rheumatism by carrying a bit of carbon about their persons. John was told that there is no electricity in the carbons taken from arc lamps. To that he made answer that he had as witnesses the policeman on the beat, the two letter carriers that came to the building, a dozen truckmen and tug boatmen in the neighborhood, and most all the waiters, cooks, and bartenders in an adjacent hotel, all of whom had been cured, as he believed, by the carbon treatment. John says that the cure is effected in this way: "I 'spects that there is a deal more 'bout 'lectricity than Massa John, and Charles and Harry (three electrical engineers for whom John worked down south) lets on as they knows; 'cause why, when I got wet down in Memphis puttin' carbons in arc lamps, I used to get rheumatiz so long as I carried the carbons in leather bags; but when I began to tote around carbons in my pockets, I did not have no rheumatiz. After that, I used to keep a piece of carbon in each pocket of my pants, and then I was well all the time. When I come north I told my minister about that, and he carried bits of carbon around in his pocket and never had any more rheumatiz. Then the brothers and sisters began to buy pieces of carbon from me and never had any more rheumatiz. Then some white folks heard of it and I cured 'em, and so my business has growed right up. 'Lectricity is in the carbon—'taint in the wires at all; you can't feel the 'lectricity in the carbon, but it's there, just the same, and it gets out and in all the time, and pizens the rheumatiz. The Bible says you can't tell where the wind comes from nor where it goes; that's just like 'lectricity; it is everywhere, and in the carbon it not only pizens the rheumatiz, but it wards off consumption, and keeps the liver and kidneys wound up and a-goin' in good shape. I am givin' some powdered arc lamp carbons to some white gentlemen that have been all busted up with kidney troubles, and they are better all ready. You see the powdered carbon gets coated all around the kidneys and insulates them, so that the pizen can't soak into 'em any more. Powdered arc lamp carbons are good for indigestion, too. I have tried it on myself, and the old woman, and the children, and it has cured all of us. If I could only get a patent on these things I'd give old Pierpont Morgan a shuffle down the pike that would make him look sick."

Light in Faraway Lands

By Felix J. Koch.

From American Gas Light Journal.

American users of gas or electric lights little reckon the importance which candles and oil still play as illuminants in far southern Europe, the principalities along the Danube, and in the upper Balkan mountains. The candle, in fact, is paramount. Every house is illuminated, when at all, with candles. These are long, white affairs, invariably tied into bunches by their wicks, and so suspended from the roofs of the several bazaars. Bazaars of a sort in a given town are always clustered together, and prices and wages are always the same. Hence, whether you buy candles in one place or in another, there is no difference at all.

Candles, despite the great consumption, are relatively high in price. In every hotel there is a fresh candle in the "stick" awaiting the roomer's use. Let him have only as much light as this, however, he is charged for the whole of it on the bill. In consequence many travelers buy a dozen candles at the outset of a voyage, using these in place of those of the hosts.

In some of the larger Balkan cities, Bucarest and Belgrade, for example, electricity has been put into the hotels by way of illuminant, but here "lumiere" is invariably charged on the bill, whether used or not.

While great Greek or Bulgar orthodox churches are not conspicuous for their illumination, there are occasions when these fanes are exceptionally bright. It is quite the custom, especially in Servia, for the

DECORATIONS IN WHICH TAPERS ARE THRUST.

churches to maintain a booth out in the vestibule, where long, yellow, wax tapers, of the thinness of a joss stick, are sold, the proceeds going to the support of the church.

When one cannot stay to say many *pater nosters,* he buys of these tapers. Then inside the church, on the altar screen, or at the rear, there is a stand (diminutive telegraph poles made of zinc), to which these tapers are fastened by melting a bit of their own wax and permitted to burn. The sight, then, is not at all displeasing.

At funerals in Bulgaria, as the mourners gather in the church in advance of the arrival of the corpse, each and all are fur-

ARC LAMPS ON BELGRADE STREETS.

nished with two or three tapers of this sort. These they light, one from another's, the first, however, having derived its light from a longer lighted taper in the hands of the dead.

At Plevnt, in Bulgaria, exists a custom whereby each and every mourner must shake hands with the corpse in its coffin. To heighten the terror of the scene, on the dead form Maltese crosses of these tapers are placed, the center of the cross being made by laying two tapers, one over another, upon a coin and then melting with wax. These ends well upturned are likewise lighted.

Furthermore, at funerals in all these Greek Church lands the corpse is preceded by two children bearing a mammoth pudding, to which all mourners are helped, and the pudding holds in its center another bunch of the bright burning tapers.

In the Balkans illuminants outside the city are almost unnecessary. The peasants, one and all, are exceedingly poor. Even meat is eaten only on great feast days and at celebrations, because of the price. Artificial light is an unwonted extravagance.

In Montenegro and some of the more southern of the States, petroleum has come into play as illuminant. In fact, riding into Cetinje, the capital of Montenegro, from the gloom of the mountains, one never will forget the effect of the heavy, old-fashioned street lamps, projecting from one corner of every house on the main highway. The petroleum can, in fact, is met with all over the Balkans, being an actual medium of exchange, passing current as a piece of money.

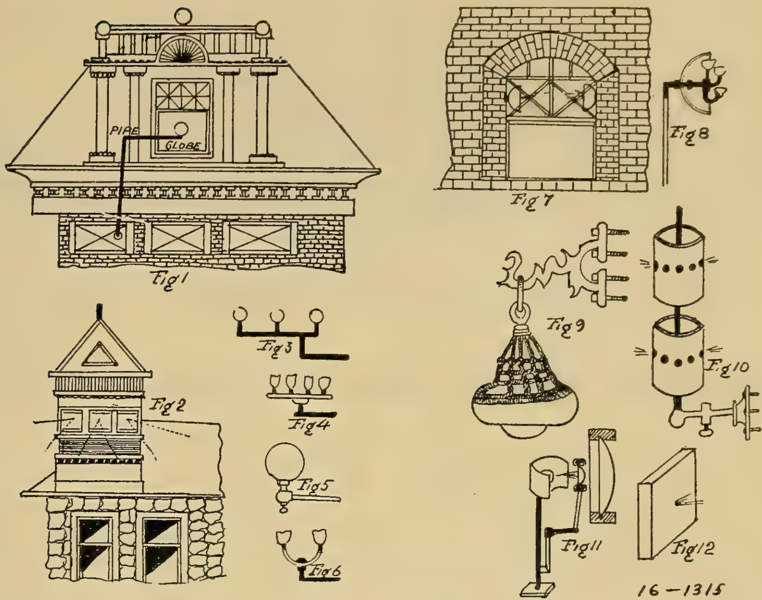
In the caves of St. Canzian, on the east coast of the Adriatic, the flashlight has already made its way, though tourists desiring the use of one of these pay heavily for the privilege, at so much per centimeter of magnesium wire used. Originally the torch was employed in showing them through the caverns.

Lighted Upper Apartments

From the American Gas Light Journal.

Judging from what I am able to see, while traveling about the world, we are fast approaching an age of upper lighted apartments of dwelling houses. That is, the upper rooms or some upper works specially erected are furnished with the necessary brilliancy of light to demonstrate that ignited flames of some kind are prevailing. There are occupants of houses who just delight in having the attic, the top girl's room, the second cook's skyscraper, the tower or the belfry of the house, lighted up as if there were a festival in progress; and, when you come to think it over, it is not a very bad idea after all. There is hardly anything so pleasing to look upon as the evenly lighted home. It is a pleasant picture to look upon the house which has its upper lights as well as its lower lights burning. The home is made much more attractive to the people. The members of the family are more likely to remain in the brilliantly lighted home. The saloon, the places of amusement and the dancing halls do not economize in light in the least. They furnish light on the outside and in the top stories, they consume light in the halls and nooks and corners everywhere. The result is they are attractive and entertaining. You cannot expect people to stay at home evenings when the rooms and halls are dark or gloomy. Therefore, I believe we are getting into a time in history when light shall count for much in the career of man.

It has long since been proven that the beautiful home is the home which sheds forth its light from the windows over the scene of darkness for the returned traveler or the wayward son. The hostess can well entertain the guests when the lights glim forth from every point of the house, whereas if the place is poorly lighted the entire evening drags and something seems to be lacking. Consequently there has been a great demand in recent years for the introduction of lights for remote corners of houses. The towers have been entered and the apartments of the attic, where the owls formerly held sway, are now fitted with apparatus for diffusing light over the attractive scenery. The loving housewife delights in having the upper section of her home shining with the glow of colored lights. As a result of these systems of lighting unoccupied rooms in the upper portions of houses, we find that numbers of plans have been installed. At one home, where there were no other means of communicating a gas jet to an attic room, the gas pipe was run on the outside, having passed out through the window of the story below, entering the window above, as per the pipe line shown in Diagram 1, but as a rule the pipes can be tapped on the inside and the line extended up through a floor to the attic room. I have seen rubber tubing used for this service, but it is better to have the gas man call and install a regulation outfit of pipes and jets. Of course there are those who insist upon using the candle, the oil light or the portable



gasoline or carbide gas outfits for lighting upper and distinct rooms. A great deal of annoyance is experienced when this is done.

The cat may upset the lamp; the candle may burn low and set the stand on fire, or something may happen to almost any description of portable light. Gas is the best for this service because it is safe. The upper rooms are not used very much in some homes, and you do not want to have to run up the stairs every hour of the evening to see if everything is right. Some put in electric lighting systems for the lights for the unused attic rooms, the towers and kindred apartments. There can hardly be anything more pleasing to look upon on a dark night than the red or other colored lights of the tower of the stable. Fig. 2 is a drawing of an installation of this order. The several lights are arranged so as to have one opposite each window, or else the lights can be clustered. Figs. 3, 4, 5 and 6 show some ways of planning the lamps for this purpose. In the event that acetylene gas is used, two or more of the little lava tips can be used to good advantage on one stem. It is a good idea to employ globes. The colors in the lights may be had by using colored glass in the window sash or by using colored glass globes, and both systems are employed with equally effective results. In some of the towers of buildings is placed a system of signalling with the lights. This requires a shaft to be adjusted to the base lamp, which shaft reaches down into the lower rooms through the walls—the shaft is turned by a crank, and the different colors may be cast.

Fig. 7 illustrates a method of using a double reflector light, one reflector being fixed on either side of the window frame. The lights are cast one against the other and considerable brilliancy results. The bright, white light, made with air pressure on a tank containing gasoline, is sometimes used for the lighting of the upper apartments of dwellings. The jets for this light are as shown in Fig. 8. Occasionally the light is burned on a mantle, in which case extreme brilliancy follows; still the common gas jet fills the bill about as well as any kind of light. One may see some ornamental devices used for the lights of the upper windows, and one of this order is shown in Fig. 9. It is a large hanging basket affair with the lights arranged to burn inside.

Fig. 10 shows the metal tube system of adjusting the lights for service in an upper apartment where protection from the wind is needed. There are exterior stands and archways on roofs which may be lighted up. The protecting cylinders are of sheet metal and are set so as to cover the flame. The lights pass out through the openings in the cylinders. Then there are methods of developing the lights thus generated by means of magnifying lenses, arranged as in Fig. 11. This consists of putting a lens opposite the blaze, supporting it on the frame as shown. The light passes through the lens and is magnified.

Correspondence

From Our London Correspondent

Of the making of incandescent mantles there seems to be no end; but the various makers each go their own way to court favor with the public. Perhaps the "Monarch" and "Plaissetty" may claim to have reached high-water mark, and in very short time. A syndicate has been registered here, and will in future control these mantles, working patents No. 11,042 of 1902 and No. 6,814 of 1906. The first patent protected a process for the preparation of the fabric by which the nitrates are reduced to oxides before burning off takes place; the 1906 patent refers to the "Monarch" mantles which are not burned off in the ordinary way. The fabric, in the shape of the mantle, whether for upright or inverted burners, when it leaves the manufacturers, is soft and pliable, of a texture very similar to loosely knitted stockings, and will stand any amount of rough handling, which renders the mantles extremely adapted for transportation, as they take up little space and require no particular care.

These mantles when placed upon the "Crutch" of the burner appear to be several sizes too large, but at once, upon holding a lighted taper to them, they shrink, become stiff, and adapt themselves to the general shape of other mantles. In our experience we have found the "Monarch" mantle to stand, after burning off, the roughest usage and to give a uniformly excellent illumination.

The syndicate that is exploiting these mantles has, we understand, a self-lighting mantle which will shortly be brought before the public, and of which great things are expected; at present only provisional protection has been secured. The factory as it now stands is capable of an output of 4,000,000 mantles per annum, but extensions are being made which will permit of an output of quite ten millions of mantles yearly.

There has been very keen competition between the engineers of the Widnes Corporation Gas Works, Mr. Isaac Carr, M. Inst., C. S., and the engineer of the Sheffield Gas Company, Mr. I. W. Morrison, as to who shall supply gas at the lowest price. At Widnes the price per 1,000 cubic feet ranges from 1s. 3d. (30c.), to 11d. (22c.). At Sheffield a reduced scale of prices will come, into force in March next, when the prices will range from 1s. 4d. to 1s. (32 to 24c.). Since 1901 the reductions have aggregated 10d. (20c.), per 1,000 cubic feet.

At a recent meeting of the Birmingham Section of the Institution of Electrical Engineers the relative costs of running electric lamps was under discussion. A speaker, Mr. A. Lindsay Forster, gave some figures relating to the cost of flame arcs, as given in the following table:

feet, quite recently quoted £18 for 1,000 candle-power lamps to burn for 4,000 hours, or thereabouts, including all cost of gas compression and maintenance.

The statement made by Mr. Forster was hypothetical, but the figures quoted in the cost paragraph are facts.

Cost of Running for 1,000 Hours on 220-Volt Direct Current Installation.

Table I.

Flame arc—9 ampere, 17 hours.

2,000 units at 1½d.	£12	10	0
Chemical carbons	4	10	0
260 trims (wages)	2	3	4
Repairs	2	8	0
Four lamps	£21	11	4

Per lamp, £5 8s.

Table II.

Flame arc—7 ampere. 40-hour magazine.

1,650 units at 1½d.	£10	6	3
120 trims (wages)	1	0	0
Chemical carbons	1	10	0
Repairs	3	0	0
Four lamps	£15	16	3

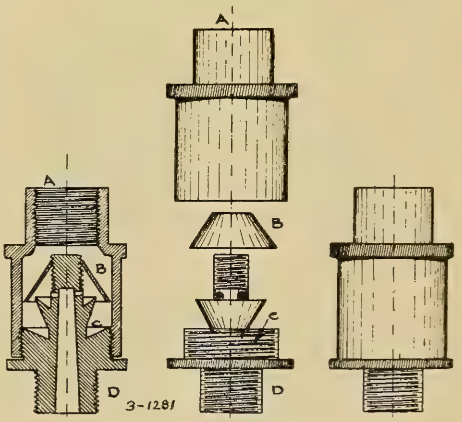
Per lamp, £3 19s.

The charge for current at 1½d. per unit is placed at an exceptionally low figure. It is noticeable that no provision is made for interest on capital and renewal charges. The speaker made no reference as to the use of these lamps for public lighting; if they are so used the old rule of 3,940 hours or 4,300 hours per annum would mean that the 1,000 hour charges per lamp have to be multiplied by four to arrive at the annual charges. On the question of cost of gas Mr. Forster had something to say: "High pressure gas (say 350 candle-power gas)," he remarked, "at 1s. 9d. per 1,000 cubic feet costs, including mantles, attendance, bye-pass, etc., £4. 6s. 3d. per 1,000 hours." Taking up this point a contributor in the *Journal of Gas Lighting* says:

"A 350 candle-power high-pressure lamp consumes 10 cubic feet of gas per hour or 10,000 cubic feet in 1,000 hours—10,000 feet of gas at 1s. 9d. per 1,000 = 17s. 6d., so that Mr. Forster allows £3 8s. 9d. per 1,000 hours for mantles, attendance, bye-pass, etc., a very liberal, but quite necessary provision."

The Gas Light & Coke Company, selling gas at 2s. 2d. per 1,000 cubic

A difficulty often very self-evident in the use of incandescent burners, is the disposing of the minute particles of dust which will deposit upon the burners, and ultimately choke, or partly choke, the nipple from which the gas issues into the Bunsen tube. Messrs. Willey & Co., of Exeter, have put upon the market a Dust Interceptor and Regulator for Inverted Burners, which is illustrated in Figs. 1, 2 and 3.



FIGS. 1, 2 AND 3.

Fig. 1 shows the gas-way and Fig. 2 the interceptor in the sections for cleaning. Fig. 3 shows the little apparatus complete. The internal

thread, or screw, shown at A, fits on to the nosepiece of fittings, B is the cone in position which prevents particles of dust entering the gas-way and choking the burner. The pressure of gas is adjusted by screwing the cone up or down; C shows the cavity which receives and retains the particles of dust. The inverted burner is screwed on to the screw D.

There would appear to be no uniformity in the shape and form of fittings for incandescent gas burners. A patent has recently been taken out by Mr. L. S. Lieberman, of London, for a fitting to carry both an upright and inverted burner. The inventor says: "Sometimes it is desired to have an upward illumination and sometimes a downward, and sometimes both together."

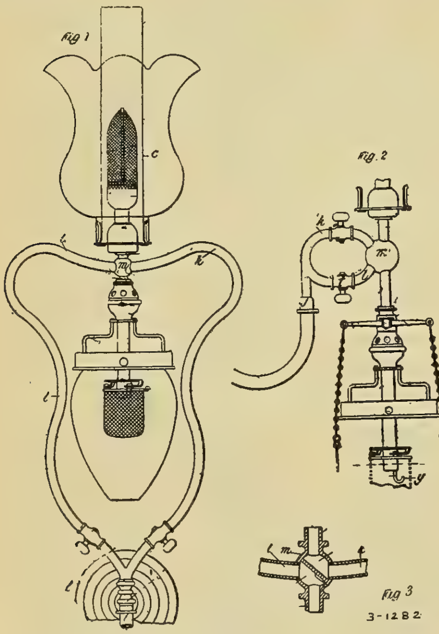


FIG. 4.

The illustration, Fig. 4, shows two methods by which, it is claimed, these requirements can be fulfilled. The following technical description of the illustration is given by the inventor. By means of the fitting *m* (shown in section at 3), and the taps *t* and *s*, gas can be supplied to either or both of the burners. At 2, the inverted burner is shown fitted with a bye-pass, the open end of which is turned out and up as at *y*, to bring it outside the circumference of the burner tube. It is claimed that this construction prevents firing back in the burner.

What effect the heated fumes from the inverted burner will have upon the illuminating power of the upright incandescent burner is not told us. At least the inventor may claim some originality for his suggestion, but whether it will have any practical outcome we should not like to prophesy.

In Great Britain we have had during the last twenty or thirty years periodical "booms" of air-gas. Generally these are attributed to the active minds of venturesome members of the Stock Exchange; still, for isolated mansions, institutions and factories the air-gas generator serves a useful purpose.

Recently we were looking up the subject and found a very interesting article upon "Air Gas," from the pen of Mr. F. R. E. Braustar, which appeared in the *Journal of Gas Lighting*. After describing the convenience and usefulness of small installations, he refers to a report by two eminent authorities upon gas matters in this country, Professor Vivian B. Lewes, and Dr. Boverton Redwood, in the course of which it was stated that an air-gas made from ordinary petrol, containing only 1.52 per cent. of hydrocarbons to 98.48 per cent. of air, forms a non-explosive mixture; and although it has no smell, there is no danger from escape, as the air required for combustion is mixed with the hydrocarbons before it enters the pipes. Very little, if any, of the oxygen from the surrounding air is consumed by the special burner used,

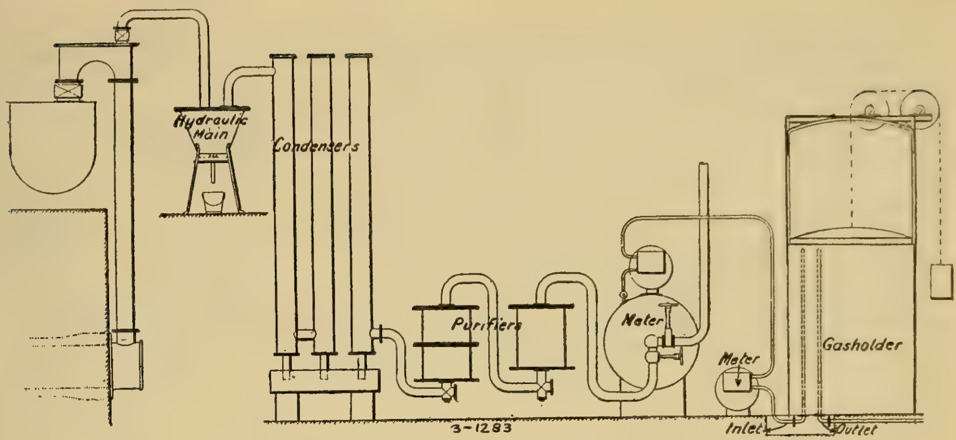


FIG. 5.—COMPLETE PETROL OR AIR GAS INSTALLATION.

which produces the light with an incandescent mantle. In this manner, it is said that a light of about 800 or 900 candle-power can be produced at a cost of 1d.

The author continuing says that this is considerably more than can be gotten from coal gas at ordinary pressure with upright incandescent burners, but about the same as is realized by the best burners of the inverted type.

The illustration that we give in Fig. 5, shows a plant, which consists of a hot-air motor A, worked by gas produced by the apparatus, which drives the blower B; this supplies the necessary current of air to the carburetter C, and the auxiliary air supply. The weak gas that is thus made passes into the small holder D, and thence to the various burners. The cooling tank for the engine is shown at E, and the petrol container at F.

The writer states that the whole apparatus, being automatic, produces the exact amount of gas required according to the number of burners in use. The quantity of petroleum vapor existing in the air in a given space depends on the temperature; it then unites or combines mechanically and finds its way among all the particles of the air so as to fully saturate them.

The question of temperature is, we know, a serious one in the manufacture of this gas, more recently called petrol gas. The passing of air through the carburetter, or generator, is in itself apt to lower the temperature even to the freezing point, and when that is the case but little vapor is evolved, and the resultant gas is of very low illuminating power.

In our own experience we found it necessary to maintain a temperature of from 60 to 70 degrees in the generator house, and to take care that the air passed into the carburetter by the blower, did not fall below the figures mentioned. We know, of course, that much has been done in the last few years to improve the manufacture of air or petrol gas; but two difficulties are still unsurmounted: first, the large volume of gas required; and second, the necessity of keeping the air employd in the process of manufacturing the gas at a high and equable temperature. In America there are not the same difficulties to encounter in respect of the supply of petrol as obtained here; very stringent restrictions are enforced in regard to storage insurance of buildings, etc. Petroleum spirit of 650 degrees specific gravity

is dangerous stuff to store in quantity, and precautions are distinctly needful.

It is now very general in connection with large gas undertakings to have a complete experimental plant for manufacturing gas. Quite recently a very elaborate work was installed in connection with the Birmingham Corporation Gas Department. Such a plant, however, would be quite out of the question with the rank and file of gas works, but many might be able to put down such a plant as the one arranged at Marseilles by Messrs. I. Verdier & P. Teular; the general scheme is illustrated in Fig. 6.

The plant consists of a retort in one of the settings in general use, isolated from the work's hydraulic main, but connected to a special hydraulic main, and a complete system of condensers, purifiers, and station meter, as shown.

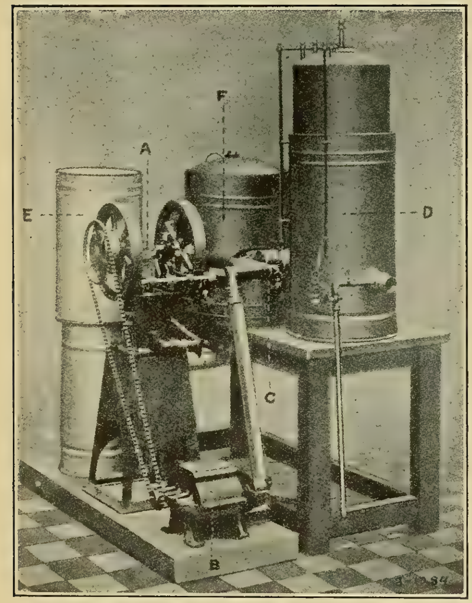


FIG. 6.—EXPERIMENTAL GAS PLANT.

It will be noted that the station meter is surmounted by a small test meter which takes off automatically from one-fiftieth to one-thirtieth of the gas produced; this gas is sent into a holder of suitable capacity, about 50 cubic feet being considered amply sufficient. The remainder of the gas may either be blown off into the air or sent forward into the ordinary town supply main.

The sections of the various apparatus and of the connecting pipes are such that without the use of any exhauster, and maintaining the pressure at zero at the outlet of the meter, the pressure in the retort will not exceed 8/10ths of an inch. The operation can, therefore, be carried out under excellent conditions, in accord at all points with the conditions of ordinary working.

With such a plant a careful study of the gas produced on a manufacturing scale, and ordinarily supplied to the town may be made.

At Marseilles this experiment is in daily operation, being specially useful for testing various coals and for the many research purposes which tend to advance the science of gas manufacture and the betterment of illuminating coal gas.

Illuminating Engineering Society

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GROTZ 1907

Abstracts of Papers Read Before the New York Section, March, 8th.

Lighting of the Offices of the Consolidated Gas Company, New York

By Wm. J. Clark.

Pursuant to an announcement that this meeting was to take the form of a symposium, at which the lighting of large interiors would be discussed, I took this as a license for the layman to briefly hold forth, and my remarks will be confined to a brief résumé of some of our office lighting. I purposely avoid the term illumination, as I know of no instance where the illuminating engineer was consulted in this most important matter, and I hope by reason of this omission to accentuate the necessity of having the architect and builder and subsequent occupiers benefit by the valuable suggestions of this comparatively new specialist.

The buildings which gas companies occupy for office purposes are either rented premises not specially designed for such purposes, or buildings owned by the companies, the building of which antedates the advent of the illuminating engineer, so that we approach the lighting problem with one of its chief difficulties very apparent, that of the irrevocably fixed points at which the radiants must be placed.

As to the offices of the Consolidated Gas Company, take the case of the Irving Place branch. This building is over fifty years old, and has passed through many transition stages of gas lighting; in fact, the story of its equipments would be a résumé of all the types of burners used in fifty years. In the remodeling of the building some years ago, evidently no thought was given to using large unit radiants, as no provision was made for ceiling pendants, the lighting being done from a purely utilitarian point of view, and the means being two-arm standards on the individual desks. Of course the general illumination was poor, the light being reflected downward by metal shades from a plane about five feet from the floor. This left the thirteen feet to the ceiling above this light plane in semi-darkness and presented a poor and unsatisfactory appearance. These desk standards at one time were equipped with Welsbach lamps, one on each arm, but the difficulty of maintaining them, owing to the constant jar caused by the handling of large, heavy ledgers led to their discontinuance, and the flat flame burner was again installed. These are now largely out of use by reason of the installation of gas arcs. This equipment consists of six groups of four four-light gas arcs, hung from the eight-inch-diameter iron columns. The floor area of the room is 3,264 square feet, and the candle-power yield of the radiants is approximately 200 candles for each lamp, or say in all approximately 4,800 candles, giving, if equally diffused, a yield of say 1.47 candles per square foot. Of course, much of this light is wasted in the grouping of the arcs, and the actual spherical candle-power of the cluster would not hold up to this rate of efficiency, and, more-

over, the walls afford little, if any, reflective diffusion, the ceiling being a dark oak paneling effect and the side walls and trim very dark. Notwithstanding these disadvantages the light is sufficient to admit of discarding the use of the desk standards. The efficiency of these lamps is taken care of by a maintenance company which looks after glass and mantle renewals as well as adjustment.

The Forty-second Street office is in a more modern building, and the ceiling drops are fairly well distributed for general illumination. Here we have installed thirty-one gas arcs of the same type mentioned above, with a candle-power yield of approximately 6,200 candles, with a floor space of about 9,700 square feet, approximately .639 candles to the square foot. The ceiling is fourteen feet high, and that, as well as the side walls, is nearly white. These conditions, with the better distribution of the sources of light, make the lesser candle-power per foot, as compared with the Irving Place rate of 1.47 per square foot, much more effective. These lamps are not grouped in the Forty-second Street office, but hang about fifteen feet between centers, running north and south, in a 200-foot-long room, and from eighteen to twenty-four feet between centers running east and west. In lighting this space we found the old difficulty facing us of the fixed points for the lamps. In laying out our floor space the first consideration was the facility with which the business could be handled at the points where the public is to be accommodated, providing ample room to handle large numbers at one time, ample passageway and partitions for department purposes. After all of this was planned for, the arrangement for lighting was taken up, with the result that the ceiling pendants were in hit-or-miss places. However, the result is not bad, and the general illumination rather good, but desk lights have to be used in the bookkeeping department for specific desk lighting.

We have tried one or two intensified pressure systems with more or less satisfaction, noticeably the Sugg system, burning the gas under a pressure of eight inches of water, with a candle-power yield of upwards of thirty candles per foot of gas consumed. This system is largely in vogue in London and is an active competitor of the electric arc for the illumination of large areas both indoor and out. With this and the Keith intensified lamps many electric installations have been displaced. These systems are very little used in this country as yet, but their projectors look upon this as a promising field for promotion.

One of the evidences of the tendency of the time toward large intensified units is apparent in the equipping of armories and markets with arc lamps in places of the strings of piping carrying flat flame tips. One has only to walk up the East Side avenues, New York, to be impressed by this. In former years almost every corner market or provision store was equipped with these string lights. In fact, the running of these outside strings was a part of our shop work, which was assigned to a special force, so generally was it used at one period. This method of lighting has almost entirely disappeared now, the more sightly or economical arc lamp having taken its place.

I submit this brief paper in accordance with an understanding that it was not to be an attempt in any way to expound any technical point or to advance any scientific suggestion, but simply to bring before the meeting a layman's view of the very great value it would be to everybody concerned if the illuminating engineer could be brought into closer touch with the architect, builder and fixture man, and last, but not least, with the decorator.

Comparsion of Methods of Office Illumination.

By Edward A. Norman.

The object of this paper is threefold:

First—To show results obtained by three different methods of office illumination.

Second—To compare the relative efficiencies of the different methods.

Third—To present results secured by arc lamps of the concentric diffuser type in a draughting room.

The two places selected for these tests were the Harlem District office of The New York Edison Company, at 27 East 125th Street, illuminated by means of cove lighting and Holophane clusters, and the draughting room at the general office of The New York Edison Company, at 55 Duane Street, lighted by diffuser arcs.

The following data are taken from the report of a test of the installation:

HARLEM OFFICE DATA.

Approximate Dimensions of Room.—Front Section—37 feet long, 23 feet 8 inches wide, 28 feet 6 inches high. Rear Section—51 feet 4 inches long, 23 feet 8 inches wide, 23 feet 3 inches high.

Finish—Ceiling and walls light cream color, lower walls dark finish, in front of room. Ceiling broken by skylights and front and rear walls by windows, as shown in Fig 2.

The cove of special type is placed 4 feet 9 inches below the level of the ceiling, on the side walls, and contains 280 16-candle-power clear lamps, 140 on each side. The wiring is run in conduit with condulets every 8 inches supplying the lamps, which are placed with axis horizontal. This conduit is in sections and may be lifted entirely out of the cove to facilitate repainting or cleaning.

Six Holophane clusters of a special type, two of which were equipped with 100-watt Gem lamps and four with standard 16-candle-power lamps, were installed, not so much with the idea of increasing the illumination as to give direction to the light. These are shown in Fig. 2.

The comparative tests were confined to the rear of the office on the mezzanine floor. Tests in the front of the office were made simply to show diffusion.

In order to make a comparison of the cove lighting with one of the most efficient forms of incandescent lighting known, two rows of incandescent lamps, 42 in each row, were strung temporarily along the ceiling, tip downward, equipped with Holophane concentrating reflectors, number 26-31.

Illuminometer tests showed the following results:

Maximum foot-candles	3.28
Minimum " "	2.20
Average " "	2.69

From the results of the tests the following deductions may be derived for the rear portion of the office:

Area, 1221 square feet. Volume, 28388 cubic feet.	Cove.	Ceiling.	Clusters.
Watts per square feet	7.47	3.41	1.96
Watts per cubic feet	.321	.147	.0842
Candle power per square feet	2.41	1.1	.71
Candle power per cubic feet	.104	.0473	.0304
Average foot candles per watt	.00042	.00131	.00091
Average lux per watt	.0045	.0141	.0098

On the basis of these figures, therefore, figuring the ceiling lighting as 100 per cent., the cove lighting would have an efficiency of about 32 per cent. and the cluster lighting an efficiency of about 69 per cent.

The following results are quoted from the report of the test:

In considering the above, it should be remembered that the ceiling lamps and the cluster lamps suffer somewhat in comparison with the cove lamps because improperly centered over the space selected for the test. The comparison is somewhat invalidated because of this unfortunate lack of symmetry in the three installations. It is probable that without sacrificing illumination intensity at other stations, the values at Stations Nos. 6, 7, 13, 14, 20 and 21 could have been increased with the ceiling installation. An undue proportion of the light from the cluster installation is directed toward the front of the room and is not accounted for in the foregoing tabulation. Any derived figures showing sacrifice in efficiency occasioned by the use of the cove lighting system are therefore unduly conservative.

It is obvious that in this installation about 68 per cent. is sacrificed for certain effects.

Let us consider the effects.

While diffused lighting by the cove method is very attractive and while undoubtedly it possesses the virtue of not offending the eye by a high intrinsic briliancy at any one point, it is nevertheless trying to a certain extent, due, possibly, to the fact that no matter where the eye rests the same uniform illumination prevails. For instance, when one looks up from a book or paper it is impossible to rest the eye by gazing at any dark portion of the room, due, possibly, to the inability of the eye to focus properly, as distances are very deceptive. It was noticed that the walls were relatively brilliant under the diffused lighting as compared to the effect produced by the ceiling lighting, due to the fact that the office is narrow. As, however, this class of lighting is only applicable to small or narrow rooms, this might be said to hold good in most installations of the same character. The absence of shadows is also very noticeable. When we enter a room where the illumination is so well diffused that the source is concealed and shadows do not exist, we experience a strange feeling that is not easily overcome, due to the fact that we have been accustomed in ages

past to associate a shadow as well as a source with all light.

The chief objection to direct lighting, although well diffused, is due to the fact that the glare of the lamp is offensive to the eye. Much higher illumination is also necessary, as the iris of the eye contracts under the glare of the direct light, consequently the general illumination must be increased. We have all experienced the temporary blindness caused by gazing directly at the sun; the same effect is produced, in a lesser degree to be sure, in an installation where an illuminant of high intrinsic brilliancy is visible.

Much less illumination is needed where the source is concealed and the light well diffused, as the eye can better accommodate itself.

It cannot be denied that there are advantages and disadvantages in both systems. Several remedies suggest themselves:

I. To use what might be called direct indirect lighting; that is, to place the lamps in the ceiling in bays behind ground glass, so that the light is well diffused, although the source is not concealed. The auditorium of the Engineering Societies Building is an excellent illustration of this style of illumination.

II. To use deep reflectors where the light itself is not visible. Where the ceiling is high and the lamps are out of the line of vision it is possble to use a more shallow reflector.

III. In my opinion, for incandescent lighting, a combination of the direct and indirect methods forms an ideal condition. There one has the advantages of both, while the combination of the two forms would to a great extent remove the objections that hold when each is used singly. Possibly the use of lower candle-power lamps in the cove, leaving the major part of the illumination to more direct methods, would produce not only a pleasing effect, but would tend to increase the efficiency of the installation. The diffused lighting would have a softening influence upon the glare of the direct lighting. During the day illuminants of high intrinsic brilliancy are not objectonable to the eye. To a certain extent this same result may be obtained by means of diffused lighting.

The data which follow are taken from the report of a test of the Duane Street office:

Drafting Room.—New York Edison Co. Dimensions: 24 feet 5 inches wide, varying from 52 feet 4 inches to 71 feet long, and 13 feet 6 inches high. Diffusers 11 feet from floor.

Finish.—Cream color, window shades same color. Lighted by 5¾-amp. multiple inclosed arc lamps, concentric diffusers with inverted alabaster globes.

Maximum foot-candles..........	16.2
Minimum " "	8.6
Average " "	13.5
Watts per sq. ft...............	8.01
" " cu. ft...............	.593
Average foot-candles per watt...	.00111

The diffusion, as you have noted, is very good, and notwithstanding the fairly low ceiling and the high illumination, the light is not at all objectionable. A personal canvass among the men working under these lights confirms this opinion.

It is interesting to note the similarity of the "foot-candles per watt" of the arc and of the ceiling lighting. No direct comparison, however, can be made of the arc lighting with the other forms on account of their different environments.

Lighting of Office Spaces

By S. B. Burrows.

Mr. Burrows' paper was mainly devoted to an examination of a number of cases of office lighting; illustrations of which were shown by lantern-slides. The first view showed the lighting of the office of the Brooklyn Edison Company, which Mr. Burrows considered an example of the best type of illuminating large offices, and which he describes as follows:

"Before this office was made into one space the several departments occupied separate rooms which were lighted by incandescent units both for general and placed lighting, and the present arrangement has done away with much of the eye-strain which usually accompanies desk lighting, and the general effect is much more pleasing.

"Concentric diffuser arcs are hung ten feet from the floor, one to every 225 square feet of floor area. The foot-candles have not been measured, but in this class of illumination from two to four-foot candles are permissible, preferably lower than four-foot candles.

"The finish of this room is a dark yellow and not the best reflector."

Another style of illumination, in which 250-watt Gem lamps are used, was shown in another view. In this case special lighting for the desks was provided by 32 c.-p.

clear lamps, with the regular green and white opal shades. Of this arrangement the writer says:

"This illustrates the usual tendency, where localized lighting is employed, to increase the size of the units and to use clear glass lamps in order to get all the light possible from the unit. The clear glass is the cause of the striations noticed when these shades are used; the frosted unit would do away with these streaks, and the shade should never be used with clear lamps for this reason. In this illumination an eight-candle-power frosted lamp would give sufficient illumination of from two to four-foot candles.

"The room is 20 by 50 feet, and the watts per square foot one and one-half. The illumination would be improved by raising the unit eighteen inches, as the present lighting is irregular. Under the lamp the illumination in foot candles is twice what it is midway between the lamps. The exact figures the writer has not obtained. This is merely an estimate.

"Probably a still better illumination would be produced by four concentric diffuser arc lamps. The wattage would be about the same as at present, including the desk lights, and the general effect much more even. Localized lights should not be used with arc units, as the incandescent lamps would be overpowered by the white light from the arcs, and it would be unnecessary, with four arcs, to use local lights."

The next view showed what the writer stated was the "worst example of illumination which had been his misfortune to see." The illumination was mainly by clusters of bare lamps under flat porcelain reflectors, with some additional desk lights. Commenting on this, he says:

"The first point which impressed itself on the writer was the need of better general lighting than is now obtained by the use of clusters which, as can be seen, are few and far between. The desk lighting is given by 16-c.-p. lamps, in some cases 32 c.p.

"The first improvement suggested is to change all the desk lights to 8-c.-p. lamps, then cut out the clusters and put in 100-watt lamps, with a style D reflector, wired with ceiling receptacles and arranged three in a row from side to side, and in the center of the spaces between the beams, shown in the photograph. This would not give ideal illumination, but is the easiest and cheapest way to improve it. The circuits could be taken from the present main lines, and the wattage would not be increased. If the Gem 187-watt lamps were used the general illumination would be much better."

He next took up a problem in which the decorative effect was as much to be considered as the question of efficiency. This was the offices and banking-room of a Trust Company in Brooklyn, of which he gives the following description:

"We have the general illumination of the public space and localized lighting to consider and also the effect of the illumination on the decorated walls. The general illumination is by means of concealed lights around the dome, and the globe lighting on the partitions illuminates the lower part of the space and brings out the general line of architecture. This is a well-illuminated office and the general effect is very pleasing.

"The units on the partitions are 16-c.-p. clear lamps with frosted outer globes. The concealed units are 16 c. p., the light being reflected by the white surface of the coping.

"The local lighting, is by means of 8-c.-p. frosted units with standard porcelain reflectors, white inside and green outside.

"It can be readily seen that arc lamps could not be used in this class of illumination, first, because of the coldness of the light, and secondly, the lamp does not lend itself to artistic treatment; also, where the local incandescent lights are used, it is not permissible to use the arc for reasons noted before."

After showing views of another banking building, he summed up his observations as follows:

"In large, open offices the concentric diffuser arc is very efficient and satisfactory where the artistic sense is not considered, and with this unit no desk lighting is necessary.

"In partitioned spaces smaller units should be used and placed units can be well utilized with a desk illumination of from two to four foot-candles.

"In spaces where the lines of the building must be brought out and a soft general illumination is necessary, the incandescent unit is the best to use, as the arc and other large units do not lend themselves to artistic arrangements."

Lighting of an Office Building

By Charles M. Cohn.

Among the buildings erected in Baltimore shortly after the great fire of 1904 was the office of this company, whose former office building was destroyed on the first day of the fire. The site selected is a

short distance beyond the limits of the burnt district, and is in the heart of the principal retail section of the city.

In the rebuilding of the burnt district, now almost completed, the company took advantage of the opportunity for the improvement of the system of house-piping, and was successful in having generally adopted by builders and architects the specifications formulated and recommended by the American Gas Light Association. The arrangement of the house-piping in the new building of the company was done in accordance with these specifications, which merely embody the ideas we advocate.

In the lighting of the offices of the company, the economy of the arrangement was carefully considered, but the matter of economy was subordinated to the broader questions of good illumination and ornamental lighting. The efficiency of the mantle burners made the matter of light absorption by suitable shades a matter of little importance. The mantle burners were used exclusively throughout the building, and the cylindrical shape of the mantles themselves aided greatly in the decorative features of the lighting.

The first floor, which is used by the public and by the office force coming directly in contact with the public, handling orders passing to and from the Distribution Department, is satisfactorily lighted by side brackets attached to the six pilasters at the sides and the three columns in the middle and side of the room. On each of the pilasters a five-arm bracket is placed, and on each of the two columns in the middle of the room four three-arm brackets, and on the column on the side of the room two three-arm brackets are used. The approximate number of square feet in this room is nineteen hundred, the height of the ceiling is fifteen feet three inches, and the lights are about nine feet above the floor. The brackets are of Flemish design, finished in brush brass, and are equipped with Enos socket burners, arranged for electric glassware. The generally recognized objections to the extended use of mantle burners—the unpleasant whiteness and glare—were overcome by the use of amber-tinted shades, sand blasted inside. It was to remove these disagreeable features that considerable effort was made to find shades that had a soft amber, yellow or pink tint, and in trying to procure shades of this character we communicated with a number of glass manufacturers and burner manufacturers, and we were told that nothing could be had at a reasonable price excepting the gaudy etched shades that are found so often in connection with cheap fixtures. It is a remarkable fact that so little progress has been made in suitable glassware for incandescent gas burners. We were, however, finally able to persuade a well-known glass concern to make up for us some special samples carrying out our ideas, and from these samples we found an amber-tinted shade so satisfactory that we at once secured a large number of them for our own use as well as for the use of our gas consumers. While we find this shade absorbs from thirty to thirty-five per cent. of the light, it is very desirable and popular.

In the private offices on the upper floors of the building four and six-arm brush brass chandeliers of simple designs are used, amber-tinted shades being also used on these fixtures, some of which are equipped with Enos socket burners and others are the combination arrangement of fixture and burner known as the Enos Bunsen fixture. The illustrations of the fixtures in the general manager's office, shown in Fig. 2, and the fixtures in the directors' room, shown in Fig. 3, give a pretty fair idea of the lighting arrangement of these offices. In addition to these chandeliers, swing brackets with Welsbach burners, fitted with Holophane Bobesches, with ten-inch opaline dome shades, are generally used for desk lighting, placed about four feet above the desk, and have been found very satisfactory in providing a soft and easy light for office work.

The bookkeeping department and the drafting room of the Engineering Department, both being of nearly the same area as the first floor, are lighted with a number of single-mantle burners, connected with ceiling outlets, the burners having a white enameled metal chimney three inches in diameter and twelve and a half inches in height over a short clear glass chimney. They are a modification of the burner recently put on the market under the name of the "Lucas light." These lamps are finished in brass and white enamel, which form a pleasing combination, and have been found to be highly efficient, giving from thirty to thirty-five candles per cubic foot per hour of gas burned, and give a good distribution of light. They are of 200-candle-power each and have been found, commercially, to be very satisfactory where an efficient light is desired for lighting large spaces.

Another attractive combination, which is used in the offices and in the toilet rooms, is a two-arm pendant holding a Welsbach

burner with a Holophane globe fitted closely around and almost entirely covering the brass shade holder of the burner. An improvement in the shape of the globe, so as to conceal as far as possible the brass shade holder, was first suggested a few years ago by this company in its desire to improve the crude appearance of incandescent gas burners, especially when contrasted with the neater and more attractive appearance of electric burners. This combination is, of course, well known, and calls for no further comment.

In the planning and laying out of the piping of the building an abundance of outlets were allowed, and upon the completion of the building such of these outlets were used as were deemed necessary for good illumination. Practical experience was largely followed, with the result of an abundance of light throughout the building and a pleasing and attractive effect from the arrangement of the lighting and fixtures.

No attempt has yet been made to measure the amount of illumination at any one point, although a study of the conditions, showing the exact amounts of illumination on the desks, floors, and various parts of the room, is purposed on the first convenient opportunity.

Discussion

Mr. E. L. Elliot referred to the lighting of the drafting-room of the New York Edison Company. It appeared that the foot-candles run from 8.6 up to 16.2. This he thought an exceedingly high intensity, although the reader of the paper assured us that those working under the light had no complaint to make. He thought perhaps it was at the same time to the advantage and the disadvantage of the illuminating engineer that the user of the light is willing to give almost any kind of testimony. The testimony of those working under a light would be naturally supposed to be a very good criterion by which to judge of the illumination, but he thought there were a great many personal errors that come in, and that it is not always as safe a guide to go by as many would suppose. He had found in his own offices that anything he put up was "splendid," whether it was good or bad. An intensity of 15 foot-candles on a reading table he had found almost unbearable, for particular uses, such as reading or drafting, he thought that special illumination must be the solution, although illuminating engineers do not all agree in this. Many attempts have been made to provide a sufficient general illumination in a room so that no special illumination will be required. Personally he found such illumination very tiresome and much preferred a special illumination directly on the work.

In Mr. Cohn's paper he was particularly interested in the search for a tinted glass which should give a pleasanter tone to the light from the Welsbach burner. He ran across this problem about ten years ago when he was with the Holophane Glass Company, when they were first beginning to develop their system. The ordinary gas mantles that were produced then gave a much more perceptibly green tint than the commercial mantles at the present time, which seriously militated against the Welsbach light for use in residences and drawing-rooms where this green tint was especially objectionable. Mr. Cohn spoke of an amber tint as giving an absorption of some 30 to 35 per cent.; he was not at all surprised that it should give an absorption as high as that, for amber-tinted glass is simply a glass smoked all through. The color is literally produced by smoking—by throwing into the glass-pot any kind of organic matter—sugar, oats, straw, whatever the maker sees fit—and the carbon distributed through the glass gives it the amber tint. There is, however, a tinted glass that can be produced which has the exact tint necessary to reduce the light of the Welsbach burner to the color of a good incandescent electric lamp, and fortunately this color is one which is dissolved in the glass. The difference in absorption between glass with the color dissolved in it, and an amber glass, may be compared to the difference between the light going through a solution, and light going through milk, or oily water, for instance. Unfortunately it is impossible to produce a deep color of this particular tint. No matter how much of a chemical you put in, you only get a certain amount of color, and the color is not deep enough to give the desired tint in the thickness of ordinary glass.

When this color was worked out he was quite enthusiastic over it, and the Holophane Company did considerable advertising; but they were apparently some years ahead of the times. The glass didn't take with the public and was withdrawn from the market. In the matter of color he considered it simply perfection for use with the Welsbach light, and its absorption was only about 10 per cent.

Mr. Norman, replying to the first re-

mark of Mr. Elliot, said that the light in the Duane Street office was not objectionable at all, notwithstanding the intensity; in fact, it was found not to be as objectionable as the cove light in the Harlem office. He thought the most interesting comparison was of the average foot-candles per watt. In Duane Street the ceiling is 11 feet high, and the foot-candles per watt .0111. In the Harlem office, with the ceiling lighting and the Holophane reflectors, the average foot-candles per watt is .01131.

Mr. J. E. Woodwell called attention to the fact that clusters of lights in general suffer somewhat from interference; and in particular instance given in Mr. Clark's paper the loss by interference is augmented by reason of the fact that the gas arc lamps themselves contain separate mantles, in which losses by interference also result. In this particular instance, however, there seemed to be a reason for placing the arc lamps about the columns, and the architectural effect may justify the losses by interference. It is also fair to admit that the losses by interference of the light from one lamp to another occur at angles at which the light is not especially useful. Referring to the paper by Mr. Norman, he noted that the comparison was not particularly favorable to the cove lighting, and he believed that by careful design the figures given could be materially improved. He thought that this method of lighting by concealed lights should be encouraged, and that in general the efficiency shown in this paper could be improved.

With regard to the illumination of the drafting-room, he was glad to see that some one beside himself had named a figure which was apparently high. He had been somewhat criticised for naming 10 foot-candles as being excessive; but in this case the intensity was over 60 per cent. above that figure; so that he was in good company, at least. He considered it good advertising for central stations, but not much of a recommendation for illuminating engineering. The high intensity, however—if it be true that the lighting in this particular case is not accompanied by an objectionable eye-strain—shows the important part that diffusion plays in the illumination of drafting rooms, and of office spaces in general; so that we can safely use higher values than we have been accustomed to, provided we secure a proper diffusion. In other words, if we work with a light-source of low intrinsic brilliancy we can do away with the eye-strain. If it is a fact that in this particular case the lighting is as successful as it is said to be, it is one of the best proofs that we have yet seen of the beneficial results of diffusing the light. He thought probably that 5 foot-candles at the outside would represent the ordinary working values for drafting-room illumination; and the figure which he first named, he considered an outside limit.

Daylight values, however, he thought would show as high as 10 or 15 foot-candles, proving again that the eye is so constituted that it can take in that amount of illumination without strain, providing it is properly diffused.

One reason probably for the excessive illumination in this drafting-room may possibly result from the necessity of using a large number of units in order to obviate shadows. It had been his experience that in the lighting of office spaces it is necessary to have in any event a certain number of light-sources in order to eliminate the shadows; and in this case, where the arc lamp was used, he presumed a smaller unit was not considered applicable. It was impossible that if an arc lamp was used which would give about one-half the intensity it would be equally satisfactory, and no shadows would result if the same spacing were adopted.

Taking up the paper by Mr. Cohn, he thought that the use of diffusing amber shades was very commendable. The loss of 35 per cent. appeared rather high at first thought, but he considered the loss justified by the lower intrinsic brilliancy of the light-source; and certainly the aesthetic and architectural effects must be improved to a marked extent.

Mr. Norman thought that it was possible to get too much cove lighting. Cove lighting has its use with other forms of lighting. The direct and indirect forms worked together he thought made a better condition than either one alone. The diffused lighting has a softening influence upon the indirect lighting, and in the two together you have the shadows and the normal effects that you are looking for.

Mr. Arthur H. Elliot took up the question of amber glass, and described the processes of making it.

Dr. C. H. Sharp called attention to the fact that where indirect lighting is used for purposes of reading or drawing, or work of that kind, the surface to be observed is near the floor. Now, if the lighting is all on the indirect system, the brightness of the ceiling is going to be greater

than the brightness of the thing that is looked at. Consequently, when you raise your eyes from your work you bring them up against something that is brighter than the thing that you have been looking at, which must be very fatiguing to the eye. Not only that, but in comparison to the brightness of the ceiling the brightness of the objects viewed seems low. In other words, the bright ceiling kills the brightness of the surface that you really want to have bright. When it comes to a question of illuminating a working surface, he thought that while a certain amount of indirect illumination might brighten up the room, yet the principal illumination should be on the work.

Mr. Porter favored making the general lighting sufficiently bright for all purposes, and avoiding the use of desk lamps. Whenever he went into a large office and saw a lot of desk lamps in front of every operator or clerk, he had a sort of pity for them, knowing that the glare of lamps right in front, or just above them, is very trying to the eyes. It stands to reason that it must be so; and moreover, it is not uneconomical by any means to make the general lighting sufficient for all purposes. He believed that in nine cases out of ten it could be done with as little consumption of current for the same general effect as by the use of desk lamps, not only because of the reflection from the walls and ceiling, if they are a reasonable color, but also on account of the effect which Mr. Woodwell had spoken of, the ease with which the eye adjusts itself to a low intensity—provided the illumination is fairly uniform, and there is an absence of intensely bright surfaces. The eye can adjust itself to work with either a very high illumination, as in the case of the Duane Street drafting-room, or, as Mr. Woodwell said, could work probably equally well on much lower illumination, if it was uniform.

The general appearance of the room he thought might reasonably be taken into consideration in the case of offices, especially a public office, such as an insurance office; it ought to be more or less attractive to outsiders. It might also reasonably be made attractive to those who work in it, by making the illumination of the whole space sufficient at least to avoid any sense of gloom. This is especially true in the case of stores, or any place which caters to the public. The head of a department in a dry goods store had spoken to him of the subtle effect upon a prospective customer on coming into a room and finding it gloomy; it takes all the purchasing spirit out of him, whereas if he comes into a room that is bright and cheery from floor to ceiling, he is unconsciously in a better mood. This matter of advertising, and its effect upon the public and business is something of very great importance in places where a great amount of illumination is used. He believed thoroughly in general illumination sufficient for all purposes.

Mr. Sandford referred to two curves which had been made from laboratory tests of individual sources, and used in actual practice in a room 16 feet wide, 60 or 70 feet long, which was lighted originally with 5-ampere arc lights placed on about 9-foot centers. The illumination was between 1¾ foot-candles at the wall and 3¾ to 5½ at the center of the room, varying with the location between lamps. In order to improve the distribution and at the same time improve the economy, tantalum lamps and Holophane concentrating reflectors were placed directly on the ceiling, four lines of lights being arranged through the room on 6-foot centers. With this lay-out a very uniform curve was obtained, averaging 3¾ foot-candles. The economy with this was almost a third of the economy with the arc lights, namely, 1.83 watts per square foot, and the distribution very greatly improved. The flickering of the arc lights which had been complained of by the employees, was overcome by the use of tantalum lamps. He had found it necessary only in the case of rolltop desks to use individual lights. The cost of changes where the individual lights are used would be prohibitive where the lay out of desks is changed as often as he has found necessary. There appears to me a maximum angle between the vertical and the light which should not be exceeded in practice for general illumination in offices, and this angle, which he had not yet ascertained—would determine the spacing and also the size of the units. Replying to question, Mr. Sandford said the arc lamp was equipped with an opalescent inner and no outer globe.

Mr. Ryan dwelt upon the fact commonly lost sight of in connection with interior illumination—that the law of inverse squares does not apply when reflectors are used. Referring to diagrams which he drew upon the blackboard (see Fig. 1) he gave the following demonstration:

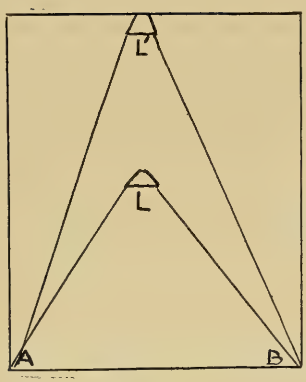


FIG. I.

Suppose a single light-source with a reflector be placed in the center of the ceiling, as L, and suppose the reflector be so shaped that it will confine the light to the surface of the floor, AB. We are now illuminating a certain area with a certain quantity of light. Now suppose the same light-source be placed at twice the height, L′, and another reflector be used which will confine the light to exactly the same surface. The lamp is now double the distance from the surface, but the illumination on the surface will be the same, since it received the same quantity of light. The illumination would therefore not vary at all, providing the reflectors were of equal efficiency. The law of inverse squares applies only where the light is permitted to radiate without reflection or change in its natural direction.

He next took up the question of the relative illumination on floor and side walls to show that measurements of illumination on a given horizontal surface do not necessarily show the total efficiency of the system. Where the light is not especially directed by reflectors, the side walls receive a proportionately larger amount of light in small rooms. Thus, if the room were cubical in shape, the side walls would have four times the area of the floor space. The larger the floor area, and the less the height of lamps on the ceiling in proportion to the floor area, the smaller is the amount of light which will fall upon the side walls. It is therefore unfair to take the cubic contents of a given space and judge the illumination upon measurements made on a horizontal plane, since the illumination will vary according to the distance of the plane from the sources. For example, if measurements were made on a horizontal plane two or three feet apart, it would be found that the curves on each plane would vary with the system of lighting used.

Referring to the drafting-room of the New York Edison Company, his recollection was that it was an old installation, and that when the concentric diffusers came out they had been placed upon the lamps originally installed without any attempt or thought of illuminating engineering. The room was very well lighted in the day-time, and it is practically true that the better the day-light illumination, the stronger must be the artificial illumination provided in its stead; 1.75 to 2.5 watts per foot was considered all that was necessary to produce first-class results. It should give somewhere from 2 to 4 foot-candles, depending upon conditions.

Referring to the criticism that the concentric diffuser is not ornamental, he admitted that it certainly was not, but that on this point there was a good deal in getting accustomed to it. These larger reflectors looked odd when first introduced, but engineers are beginning to realize that if they are going to reflect and diffuse the light over any considerable space, they must use a large reflecting surface irrespective of its appearance. He referred to a statement made by one of the speakers that white light was objectionable in a banking house. As a matter of fact, he thought such a light the exact color needed, as it was far easier to detect bad bills under a white light than under a light of any tint. Unfortunately, it was difficult to make the arc lamp sufficiently decorative for such purposes.

Replying to Mr. Sandford, Mr. Ryan thought that the equipment of the arc lamp referred to was not what it should have been for a drafting-room. In a room 25 feet wide with the lamps installed 10 feet above the floor, which is the usual working level, the lamp as described puts only 22 per cent. of its total flux directly on that level. It is possible to double the illumination on this level, and in fact it would not be impossible to push it up three times that value by proper accessories. Mr. Ryan then illustrated by diagrams the necessity of using reflectors which would intercept as large a solid angle of rays as possible, and stated that arc lamps of the ordinary size, *i. e.*, 5 to 6 amperes, could be placed so as to require not more than 2 or 2½ watts per foot, and still not give objectionable shadows. He considered arc lamps, even though of individually greater intrinsic brilliancy, less objectionable than

the comparatively large number of incandescent lamps placed upon the ceiling which would be necessary to produce an equal illumination. He referred to a prominent dry goods store in which five high-power incandescent lamps in prismatic reflectors had been placed in each panel of the ceiling. The appearance he considered "something awful." The proper way to illuminate a large area is to avoid small units as far as possible. If a single lamp could be placed so as to light an entire floor, it would simplify the problem very much, and the aim should be to reach that point as nearly as possible. The tendency should be to keep down the number of units in a large building.

Mr. Sandford did not wish it understood that it was a drafting-room he was referring to; it was an office space with flat-top desks. The matter of spacing the units farther apart is just the point which he had to make. Spacing the units farther apart makes the angle at which the light strikes the desk from that source so great that any little thing will throw a shadow. It also makes the number of sources which throw the light to any given desk a minimum so small, that if anything happens to be in the way of the proper light the man does not get light enough.

Mr. A. A. Pope took up the lighting of the Harlem office, in which he was personally interested. The effect sought was not simply the illumination on a plane near the floor, but to secure such generally effective results that they would attract the public. Arc lamps with concentric reflectors have been considered, but the difficulty of trimming was a serious problem, as they would be 28 feet above the floor. In the beginning, 8-c.-p. lamps had been used, but while there was light enough theoretically, the general impression was not good; 16-c.-p. lamps were therefore put in. These did not make the desired effect, and it was discovered that the unsatisfactory effect was due entirely to absence of shadows which gave no rest to the eye. The addition of the clusters made a very marked difference in this regard, and he believed that the lamps in the cove could be reduced to 4 c.-p., and by the use of the clusters the general effect would be as good from the artistic standpoint as from the advertising point of view.

Referring to the drafting-room of the Duane Street office, he stated that the arc lamps were hung up where the outlets had been provided. As an additional reason for the use of a high intensity of artificial light, the draftsmen all considered the lighting "just right," and any attempts to reduce it would create dissatisfaction.

Referring to the question of colored globes, he thought that in the introduction of the tantalum lamp, which has an excessively white light, there was a great field for globes of this kind. He was somewhat surprised that the absorption of the globes mentioned was as high as 30 or 35 per cent., but believed that the artistic effect produced would compensate for this loss.

Mr. Hunter thought that the matter of general illumination was not kept sufficiently distinct from that of local illumination. In lighting smaller interiors, he had found it absolutely necessary to have local lights for special reading purposes besides sufficient general illumination for the public. He considered the Astor Branch of the New York Public Library the worst specimen of lighting which he had ever seen; 16-c.-p. lamps were used with green and white shades with no provision for general illumination. As a result there was heavy shadows above the light-sources. This was not only ugly in appearance, but absolutely hurtful to the eye. The readers in this room are constantly looking up in an effort to rest the eyes. One architect had attempted to defend this method of illumination on the theory that the black shadow was exactly what was wanted, but he made the error of confounding black with a soft gray. The question of counteracting the greenish tint of incandescent gas mantles he also considered important, and believed that the failure to do so has seriously retarded the use of these burners. The question of colored shades, however, needed to be handled with a great deal of care. In regard to general illumination, the suggestion of one speaker that every part of a room should be so flooded with light that one could read easily in any part of it, he could not endorse. He thought such a condition perfectly hopeless and undesirable. He believed it quite possible to secure good illumination and decorative effects at the same time. For general illumination he considered that the units should be as large and convenient as possible, while for local illumination they should be as small as possible. He believed that the average desk light is far too strong, and that the average light for general purposes is apt to be too weak.

Papers Read Before the New England Section, January 15th.

The Progress of Electrical Illuminating

By J. W. Cowles.

Some of us can remember back into the early 80's when the first commercial arc lamps were opened to the eyes of the public, and those of us who do remember them recall also what wonderful things they appeared to be. The pictures that I remember to have seen of the early Brush lamps and the first machine put on the market by the Brush company were surely remarkable. The lamps, as I remember, appeared almost as large as the machine itself, and the lamps were certainly wonderful in that they opened up the way to a type of apparatus which very rapidly spread into innumerable styles and varieties. These lamps, though seemingly crude in the first stages, were very soon perfected and brought into commercial condition which gave excellent results. They were all of the open arc type, with clutch and clock-feed mechanism, but notwithstanding this and the comparatively crude quality of the carbons which were used, they brought forth results which from the standpoint of efficiency and watts per candle have hardly been equaled or surpassed until a very recent date. It was from these early lamps that we formed the somewhat bad habit of talking about 2,000 or 1,200 candle-power. The open arcs, however, were essentially expensive in maintenance and open to serious objections from a commercial standpoint. The short life due to the rapid consumption of the carbons, necessitating trimming every day, made them expensive both in labor and material. For street service, the fact that they were open arcs, that is, that the carbons were exposed to the weather, made them subject to serious objection.

The enclosed arc came into the field about 1893, and although it had a hard road for the first few years, it was soon brought to a state of development which very rapidly put the open arc to rout.

Quite recently the pendulum has shown a tendency to swing the other way, and we are gradually getting back to the open arc principle, through the introduction of the so-called flaming arcs. These are strictly open arcs in that they are not enclosed in inner enclosing globes, and are true flaming arcs. The magnetite lamp of the General Electric Company has shown very marked advantages for outdoor illumination—street lighting particularly. The flaming arcs of the impregnated carbon type, such as the Excello, Siemens, etc., have come into extensive use. These lamps have appealed strongly to customers and the public, largely from an advertising standpoint. Our conscience allows us again to talk of 2,000 candle-power, and even a good deal in excess of that figure, and the flaming arcs are certainly a wonderful step in advance in giving light for the money. All of these flaming arcs are outdoor lamps, since they all, to a greater or less extent, give off fumes which are somewhat objectionable for indoor use. The iron oxide fumes of the magnetite lamp make it strictly an outdoor lamp. The fumes of the Excello and the Siemens lamps, which at first were supposed to debar them wholly for indoor use, are gradually being found not to be so serious after all, and the flaming arcs of that type are being used indoors to some extent. I believe the experience is that inside enclosures large enough to require a volume of light, such as is given by the flaming arc, the fumes are not serious. These flaming arcs are inherently expensive to maintain. The carbons are treated with different chemicals or impregnated, giving different colored effects. The carbons are small in diameter, long in length, and short in life, all three conditions tending to make them expensive. They require practically daily trimming, after burning about ten hours for most of the lamps, so that they are strictly short burning lamps. Other lamps which are in sight seem to bid fair to overcome these difficulties to some extent. The arc lamps, which until very recently have maintained an efficiency practically unequaled by the other means of electrical illumination, have since been obliged to meet close competition from the development of the incandescent units of larger size and higher efficiency, so that the field of the arc lamp now seems to be to some extent limited. I cannot bring myself to believe that the arc lamps are yet "down and out," as I have heard prophesied by others. I still believe that the arc lamp will hold a certain field of its own for a long time to come; and yet for a

good many places, where arc lamps have been formerly used, they are quite out of the race to-day. The man with the small store, who formerly had one arc lamp in the center of the ceiling, should displace it as rapidly as he can by some of the more approved methods of incandescent lighting. Smaller units more evenly distributed, giving a more even distribution of his light and avoiding the objections which are always found in the case of large units prominently placed, must necessarily replace many arc lamps.

To the layman the incandescent lamp of years ago no doubt looked about the same as the lamp of to-day. The shape and dimensions are not materially different, and to the unitiated the style or appearance of the filament and the essential fatures of the lamp are about as they were years ago. However, it is quite otherwise. The early lamps, of efficiencies which manufacturers would almost hesitate to acknowledge, went through the usual gradual process of improvement, the old tedious, slow process of cutting the bamboo into strips, the treating process and the gradual preparing for service have been improved, and ingenious devices, better methods, and, in fact, radical changes in details have been introduced, until to-day the manufacture of incandescent lamps is one of the most interesting processes. From the early lamps of unknown, or unstated efficiency, the lamp has been developed up to a 3.1 watt efficiency, and at this stage it has been considered the *par excellence* of lamp manufacture. The strides which were so rapid in the first few years unfortunately came nearly to a standstill, and for a number of years the improvements, at least in the matter of efficiency, were very slow, so that until quite recently we have felt quite content with a 3.1 watt efficiency. Within the last two years, and more especially within the last year, the metal filaments have been brought out and are revolutionizing the lamp industry. The metalized filaments of the General Electric Company were practically forerunners of these types in commercial form, and this lamp, with a 2.5 watt efficiency, is now being rapidly put into service. The lamp partakes very much of the old carbon filament nature.

The tantalum lamp was the next of the high efficiency lamps to be introduced commercially. This lamp, with a rating of 22 candle-power at 44 watts, or two watts per candle, gives a very satisfactory light. With the increase in efficiency, of course, we get an improvement in the color, a whiter light, and we are getting nearer a pure white light, or at least getting farther away from the yellow color which has been such a handicap to the old carbon filament lamps. The tantalum lamp is now being introduced extensively. The retail price of the lamp is approximately 60 cents. The Boston Edison Company offers it on a renewal basis with an excess charge, the customer paying 30 cents wherever he would be entitled to a carbon lamp free. The great handicap on this lamp is that it is essentially a direct current lamp. On direct current the life is supposed to be about 700 hours. On alternating current, unfortunately, the life is very short, due to a molecular disintegration of the filament, which, so far as I know, is not fully understood yet. With alternating current the life is considerably less than 300, probably not much over 250.

The next lamp in order, though not yet in commercial form, is the tungsten lamp. The beauty of this lamp is not only in its high efficiency, getting down to practically 1¼ watts per candle, but it is interchangeable between alternating and direct current, and equally good on both, and with a life which promises to equal or exceed the present carbon 3.1 watt lamp and even the tantalum lamp. All of these metal filament lamps have one inherent valuable feature: they all have the positive coefficient of resistance of metals. The carbon filament has a very decided negative resistance coefficient, the resistance decreasing rapidly with increased temperature, so that the resistance of the lamp at the temperature usually burned is about half the normal resistance of the lamp cold, whereas the metallic filaments show the reverse, that is, with increased temperature we get increased resistance. This plays an important part, giving to a considerable degree, an inherent automatic means of regulation, thus making the lamp much less sensitive to fluctuations and variations in voltage, so that the detrimental or deteriorating effect on the lamp, of excess voltage is very much less than with the carbon filament lamp.

There has been, along with the development of the high efficiency lamp, an extensive development in shades, so that fortunately the question of the proper shades and the proper distribution of the light from the lamp is receiving attention to-day which has been wofully lacking in years past.

In a little different line of lighting, perhaps not strictly classed as incandescent lighting, is the Nernst lamp. This has been

on the market for a number of years, has built up an important business and given good service. It has a field of its own. These lamps are manufactured in standard sizes of 1, 2, 3, 4 and 6 glowers, taking approximately 90 watts at 220 volts per glower. The Nernst lamp, however, has a handicap similar to that of the tantalum lamp, only in an inverse direction. The Nernst lamp is inherently an alternating current lamp and, furthermore, is confined practically to 220 volts.

One of the newest and most interesting of the later developments in electric lamps is the vapor lamp, such as the Cooper-Hewitt and the Moore vacuum tube lamps, which are coming into service to quite an extent. The mercury vapor lamp is operated upon either alternating or direct current—not exactly the same lamp—however, in units of approximately 300 to 400 candle-power, burned as a rule in series of two across 110 or four in series across 220 volts, although single lamps for 110 volts are obtainable. These lamps give a watt efficiency which surpasses anything obtainable before, reaching a figure as low as one-half of a watt per candle, and figures even lower than this seem to have been well established. They give a good power factor, only slightly less than unity and wherever they can be used, taking into consideration their peculiar color, they are giving excellent results. For photographic work they are excellent.

The other type of lamp to which I have referred to is the Moore vacuum tube lamp. The Moore vacuum tubes are practically little else than commercialized Geisler tubes. They give a method of lighting which promises to be most attractive. This lamp is essentially an alternating current lamp, and is simply a high voltage discharge through a tube filled with rarefied gases of different kinds, so that it is simplicity itself. The whole equipment consists simply of the tube, made into whatever form may be desired, with both ends entering into a cabinet in which is a transformer, the primary of the transformer being connected to the commercial alternating current service. These lamps give an efficiency of about 1.5 watts per candle and are readily available in lengths from one up to several hundred feet, if necessary. It is simply a problem of glass welding to get tubes of practically any length. The usual practice is to run the tubes at an intensity of about twelve candle-power, or eighteen watts, per foot of tube, although 20 candle-power per foot is easily possible.

Aids to Progress in Lighting

By J. S. Codman.

The illuminating engineer is now getting assistance which he did not get several years ago, which makes it a great deal easier for him to do scientific work. About six or seven years ago the average layman had no idea that a sixteen candle-power lamp did not give sixteen candles in every direction. I think that was also true of a great many electrical men, or if it was not actually true, they did not think much about it. In general there was an absolute lack of recognition of the importance of the distribution of candle-power about a source of light. I think that was also true of the gas people. About that time a certain lamp appeared on the market, and it happened that this lamp was so designed that the filament was horizontal and had behind it a pretty good reflecting surface and had a very high downward candle-power. I do not know whether it was designed to give that or whether that was an incident of the design, but I do know that the lamp was put on the market and rated on the downward candle-power, and the downward candle-power of some of these lamps was 50. The lamp took 88 watts and the efficiency appeared to be 1.76 watts per candle. Now, it did not take long for some bright mind to conceive the idea of putting an ordinary reflector on an incandescent lamp, putting it on the market and rating it on the downward candle-power as a new unit of light. This idea was followed up in another type of lamp, having the lower part frosted and a reflector behind it. The first reflectors put out were aluminum, but they were replaced by glass reflectors. These two lamps, in spite of the exaggerated claims for them when they were first put out, were, as a matter of fact, a great advance aside from their efficiency, which was not really anything astonishing. They were in advance in other ways, but one thing in particular they did accomplish. They opened the eyes of the public to the fact that the rated candle-power was of very little importance, and that we must know the light distribution in order to understand the amount of light being given. At that time distribution curves were practically unknown. Nowadays we have photometric curves, and a great many manufacturers of incandescent lamps, globes and reflectors publish distribution curves which are of great aid to the illuminating engineer. A great many of these curves are to be found published in the transactions of

societies and in the technical papers. There was a paper read before the Western Gas Association last year in which there were 24 photometric curves given of various gas mantles, with all sorts of miscellaneous shades.

Then there is another thing that was needed to make the work of the illuminating engineer easier, and that was some sort of convenient tables. A great deal of work is being done by illuminating engineers using the law of inverse squares in their calculations. Something was needed to save all this trouble, and the majority of engineers now, I think, use various tables of their own, but nothing had been published until recently there appeared a set of tables called "Kin's Illumination Tables," which I think will be of considerable assistance. They are the first thing of the kind I think ever published and will be found very useful.

Discussion

Chas. J. Hatch.—Is the light of the Siemens enclosed flaming arc lamp such that colors may be matched by it?

Mr. Cowles.—The lamp, until recently, has been considered strictly an outdoor lamp. They are now introducing it somewhat indoors, but I do not know of their having used it under conditions requiring color matching. Their color is very good, and, due to different ingredients in the carbons, there are three or four colors obtainable. The chief one is yellow, which is the one giving the highest candle power. And there are the ruby or red and the white. I do not see why the white light carbons should not be all right for color matching and compare favorably with the ordinary arc, which is at present the most satisfactory for color matching.

John Campbell.—Has anything been done regarding smaller candle powers in tungsten lamps? The new form seems to be an endeavor to increase the candle power.

Louis Bell.—The principal objection toward getting smaller candle powers is the extreme tenuity of the filaments. The tenuity of the filaments now put out is astonishing to one familiar only with carbon filaments. The tantalum 22 candle power lamp has a filament of about 2-1000 of an inch in diameter. The tungsten filament I have not measured, but it is approximately of the same order of magnitude. That gives 40 candle power and apparently it is going to be extremely difficult with any kind of materials which are now used to get a lamp of much smaller candle power than we have in the samples which are now on the market. 2-1000 of an inch is a very small filament, so small that questions of irregularity of drawing or a slight lack of homogeneity in the filament cut a very important figure. I can hardly believe we can go on long with the introduction of these high efficiency lamps unless somebody hits upon a metallic filament of some description which will enable us to get the smaller lamps. It is extremely pleasant to think of a 50-watt lamp giving 40 candle power, as in the case of the tungsten lamp, but it would be very useful indeed if we could have an eight candle power lamp requiring, say, fifteen watts. Nothing of the kind has yet appeared, but we live in hopes, and I think the chances are fair that the steady improvement in these filaments, which will unquestionably go on, may lead, sooner or later, to the production of a small candle power lamp. At present, however, the lamps of large candle power have this in their favor, that they are so efficient that they enable us to use indirect illumination, to screen or shade the lamps in ways which give a beautiful diffused light without anywhere near getting back to the efficiency of the original carbon lamps. The carbon filament lamp, of course, is made in small sizes, but I cannot impress upon you the difference better than by saying that a tantalum or tungsten lamp filament is approximately of the same size as would be found in a five candle power lamp for 230 or 250 volt circuit with carbon filament.

Mr. Campbell.—How about the "linolite?"

Dr. Bell.—The "linolite" lamp is nothing more or less than a linear incandescent lamp, which at present is worked at approximately the same efficiency as any other lamp. The only "linolites" now on the market are carbon filament lamps, but I think we can expect that metallic filament lamps will be available before long. I should add one word in regard to the metallic filament lamp, and that is that they are looking up all the time. The tantalum lamp, for example, certainly does give, as far as we have been able to ascertain, a life which is on the whole better than that of the carbon lamp. My own experiments, which began when the tantalum lamp first came to this country, show that the lamps will stand up for something like 800 hours without falling below the 80 per cent. initial candle power limit, and that is very

good. Of course the life on alternating current is very much less, and nobody knows yet just why. The tungsten lamps are reputed to have even better life than that. However, the tungsten lamp and nearly all the tantalum lamps have this peculiarity, that the filaments are plastic, wonderfully so when heated. The osmium lamp is like a wet string when it is tipped out of the perpendicular. That objection has yet to be met. It is not a serious one from a practical standpoint, because when using a lamp it may be put in any position which is convenient and give any distribution by means of reflectors; but there is a lot yet to be done on all these metallic filaments before we come to a point of easy flexibility such as we have in the carbon filaments. From the present outlook it would be rather difficult to apply the osmium filament or tungsten filament to the "linolite" lamp. The tantalum may work better. The time is coming very fast which will admit of the use of this on a much freer scale than now is the case.

Mr. Campbell.—Illuminating engineering is coming up against a problem in residence lighting, and also commercial or store lighting. The tendency seems to be toward the larger units. The same is true with the mantle gas lamps. For a while we saw a number of comparatively small mantles, but the smaller mantles are now dropping out of the market, unless it be the inverted mantle, and the larger or higher candle power mantle is being put out.

N. W. Gifford.—As to large lights, I think frequently the purchaser of light sees a big light and thinks it is a great thing, regardless of whether it is a good thing or not, and in the mantle lighting we have seen that some people ran to excess in the use of long mantles, which good practice now rather avoids. From my experience it has seemed that the use of individual lights for store lighting has recently rather been on the increase. The motives for that are twofold. Possibly the storekeeper thinks he could get along with two single mantles for less money than for four in an arc lamp. This is partially true, but it is also true that he would get better distribution from two mantles separated than from four in a cluster. Then, too, it makes a good deal of difference where your territory is and what your customer can stand. All that has to be taken into consideration by the lighting engineer who is trying to give his customer just the very best thing for his particular needs and for the least money. However, to get the most for the money is not always the only end to be attained. The sellers of light usually know better what the customer wants than the customer does himself, and not only that, but are honestly endeavoring to give him what he wants.

Dr. Bell.—Some two or three years ago I received tests of a very remarkable German invention in mantles which apparently consisted in making a mantle which was practically vitrified instead of being of the character of the ordinary Welsbach, simply an aggregation of particles on the core, was as if made of some hard substance. Tests which I had at the time, and which came to me in such a way that I have no reason to suppose they were not absolutely correct, showed very remarkable properties. I would like to know what has become of that mantle and whether it has ever appeared in this country. It was a very curious and promising thing.

Mr. Campbell.—The other day I went up over the Fitchburg Railroad, and in one of their dining cars the lighting was by means of an inverted mantle, and the distribution was certainly good. I asked about the breakage of mantles and the car conductor, while he had no absolute way of determining how many mantles they used, said the car makes 286 miles a day, and to the best of his knowledge they did not break over, and possibly not, two mantles per trip, and that includes all the shunting that they give the car. It seems to me it is a pretty good record for hard usage of the inverted mantle. I should like to hear something about the Nernst lamp.

W. J. King.—We have found in Peabody, Mass., that the Nernst lamp had a certain field where it was successful, and I was a little surprised to find that the customers who seemed to be the most pleased with this lamp were barbers rather than store proprietors. Their preference is due to the quality of the light rather than its efficiency, although of course the efficiency is important. All are pleased with the quantity of the light, and in the stores they have considered it much better for matching goods than any form of light they have had. The question of arc lamps for matching colors has been brought up. I think anybody who will try the Nernst lamp against an arc lamp for maching colors will find the Nernst lamp preferable to any other.

Papers Read Before Technical Societies

Domestic Gas Lighting from the Fixture Manufacturer's Standpoint

By L. R. Hopton.

Read before the National Commercial Gas Association.

The first gas fixture may possibly be considered to have been the bladder full of gas which William Murdock, of Cornwall, England, lighted one evening in the year 1792 for the edification of a few invited guests. Developed first in England and introduced in this country by David Melville, of Newport, R. I., in 1806, gas as used for lighting has enjoyed a steady development. The earlier gas fixtures were curious structures, and being made before the appearance of iron pipe, were both expensive and cumbersome.

It is not my purpose to go to any further length into the early history of the gas fixture, but I do wish to emphasize the fact that as the use of gas for illuminating purposes became more general the gas fixture continued to enjoy a fairly steady development, both in workmanship and in artistic merit. With the advent of the electric lamp, however, the development of gas fixtures received a remarkable quietus, notwithstanding the fact that for a short period electric lamps were used largely as attachments to existing gas fixtures. In the case of the electric lamp this transition period did not last very long, so that in a few years manufacturers were called upon to turn their best skill and expend their best possible workmanship on the construction of fixtures for use with the electric lamp. While this may be only what should have been looked for in view of the many advantages of the electric lamp, to the man interested in gas fixtures it is not very consoling to know that over three-fourths of the fixtures put upon the market to-day having any claims to artistic merit are adapted to the use of electricity only. The introduction of the Welsbach mantle brought about a new condition of things. It has been said that the mantle saved gas from passing into oblivion from the field of illumination. While this is, of course, an exaggeration, it certainly gave gas lighting a very pronounced stimulus. Like its predecessor, the electric lamp, the first appliances for use with the mantle were crude and unsatisfactory, but they were sufficient to demonstrate the great possibility of this form of lighting from an economical point of view.

I cannot summarize this portion of my talk better than to say that we have before us two truths that may be taken to be self-evident. The first one is, that gas for lighting cannot be made as convenient nor as artistic as can electricity. The ready means of control by switches at remote distances and the absence of any grade of combustion, render the electric lamp of particular value as a lighting medium. Gas lights cannot be used to produce the beautiful effects obtained by embedding the electric lamp in ceiling and cornice decorations, nor can they be used in many of the elaborate concealed light effects. Proper disposition of the heat from a gas light must be carefully considered; and notwithstanding the spark lighting attachment, the pneumatic valve, or the self-lighting mantle, there is no device for lighting gas as readily as the electric lamp. In short, fixtures can be designed and effects produced that are absolutely impossible in gas lighting.

The second axiom is, that the electric light, candle power for candle power is more expensive than the incandescent gas light. Electricity must be generated by means of a steam boiler, engine and dynamo, while gas is generated from coal or other materials and used directly as a fuel to produce light. For domestic purposes the electric light costs anywhere from 0.5

cent to 1.5 cent per 16 candle power per hour, while the mantle gas light costs about 0.1 of a cent per hour for the same unit. I am well aware of the rapid strides being made by inventors of electric lamps and noticed particularly a very optimistic opinion expressed by Mr. Lansingh in a paper read before the American Gas Institute at Chicago last October. He states as follows:

"During the past year the situation from the electric standpoint has materially altered; there has been, in many cases, a reduction of rates, often of a more sweeping nature than corresponding reductions in gas, but the principal change has been in the introduction of new lamps of higher efficiency. The first lamp of this nature to appear on the market was the Gem or high efficiency type, consuming 2½ watts per horizontal candle power. This was followed by the Tantalum lamp, consuming 2 watts per candle power; and the electric industry is looking forward to the introduction of a new style of lamp, the Tungsten, which is promised for the market at 1¼ watts per candle power. Other types of lamps, such as the Osram, Ossium, Zirconium, Kuzel, etc., give promise of even higher efficiencies, and it is confidently expected by the electric trade that within two or three years there will be lamps on the market with an efficiency of perhaps ½ watt per candle or 1-7 of the present 3½ watt standard. Granting, however, that for some time to come, the 1¼ watt lamp will be as high an efficiency as will be attained in commercial practice, we see that the electric man will be able to reduce his current consumption from 3½ to 1¼ watts per candle or a reduction of nearly 2-3 of the present cost. We therefore see that with the introduction of a lamp of this type, gas will be placed in the same position, perhaps not quite as good, as it was when we had only the old type of burner and the old 4 watt incandescent lamp. The cost of electric lighting then will not be greater than 1½ times that of gas and with a possible reduction to equal or even lower cost."

Notwithstanding these interesting arguments, it may safely be stated that the incandescent gas light is very much cheaper than the electric lamp. Of course, there are favorable locations near abundant water power, where electricity in cost may come into closer competition with gas, but on the other hand, there are locations where nature has given the gas man an abundant supply of gas, which he can secure by merely drilling into the ground and piping. In general, it may be said that we face these two conditions: The greater adaptability of the electric light and the greater economy of the gas light. While the gas appliance man has doubtless made the most of his advantage in low cost of lighting, I hope to show that he has not gone as far as possible in the other direction, namely, the increasing of the scope and attractiveness of gas lighting.

No one knows better than yourselves the limitations of your particular fields and the needs and sectional peculiarities of the public that you aim to serve; but while each of you caters to a small section or coterie, the manufacturer of fixtures on a large scale is in touch with the needs and special requirements of all parts of the country. By our contact, not only with the buying public, but with decorators and architects, we are perhaps in a position to obtain a broader view of the situation, and to see a phase of the field of gas illumination that is not accessible to the gas appliance man. We know with what aversion a large portion of the public treats anything in the way of gas fixtures. We are constantly reminded that decorators look on them as things to be avoided, and that many architects advise against them wherever possible; and this aversion exists in the fact of increasing cost of installation, by reason of the more rigid requirements on the part of the Boards of Fire Underwriters.

While this state of feeling is principally due to the pronounced advantages of the electric light, it is also fostered in large measure by the way in which gas lighting is being handled to-day. To these people of refinement, gas lighting is associated with the ugly fixtures, crude and unfinished attachments, and all manner of inconveniences. They will cheerfully have their houses piped for gas ranges and water heaters, but are willing to pay much more for electric wiring for the use of electric lighting fixtures. Of course, this condition does not work disadvantageously to the interests of the large fixture manufacturer. He is equipped to make any style of lighting fixture that may be called for; but to the man interested in gas fixtures and the more general use of gas for illumination, it is a situation that must be seriously considered. Notwithstanding the fact that both electricity and gas are frequently furnished by a single company, there exists a

natural rivalry between the appliance men in the two departments, and the gas appliance man must do all in his power to build up and maintain his department. In cases where there is keen competition, such as exists in many Western cities, it is of still more importance that the gas appliance man do all in his power to overcome this aversion on the part of the public to the use of gas for illumination.

It seems to me that the general public may be divided in three fairly well defined classes regarding their attitude toward the question of lighting: The first class may comprise that large portion of the public which considers but two things, candle power and cost, and by cost I mean not only first cost, but also the cost of operating and maintaining the fixture or burner. To this class may be assigned all store and shop lighting, where arcs and other high candle power units are more commonly used. It may be natural to suppose that in such cases the lighting fixture is considered as a necessary mechanical appliance, useful for the few hours that it is lighted, and during this time expected to produce most economical results, but a bothersome and obtrusive piece of mechanism during the many hours that it is out of commission. While some attempt has thus far been made to construct these high power gas appliances more ornamental, it is interesting to observe the form in which the electric arc lights are being used in some of New York's largest retail stores. They are attractive and in harmony with other decorations, and the effect is noteworthy.

The gas arc has a large field of usefulness and has certainly been a boon to gas companies and appliance men. While from the standpoint of scientifically correct illumination it is questionable whether it is best to group the light into single high power units, the fact remains that as a companion or substitute of the electric arc light it has a large and growing field. In this class also should be included a large portion of the public who are interested in domestic lighting, and who are largely the buyers of the cheapest fixtures and single burners. Attracted by some advertisement or impressed by the light-giving qualities of some type of burner, they aim to get light, and lots of it. They want as much light as possible in one burner, want it with the consumption of little gas, and seem to be perfectly willing to sacrifice simplicity of construction and neatness of appearance to this end. These people care little if the burner has a Bunsen tube 3 or 4 inches long and will load it up with chimneys, reflectors, diffusing cups and metal work, if by so doing they can increase the light. They will put on a neat and well appearing chandelier a single powerful burner and use it for the entire illumination of a room. With people of this class, the fixture manufacturer rarely comes into direct contact. They buy their fixtures and their burners from supply dealers and from the gas company stores; and their purchases form a large portion of your business.

A second class we might consider is the large and fortunately growing portion of the public, which considers appearance and workmanship as well as candle power and cost. People of this class exercise greater care in the selection of their fixtures and burners and desire them to be of good workmanship and as attractive in appearance as possible. They desire a better distribution of light and prefer to use a smaller number of units on their fixtures, even though the first cost and the cost of maintenance are a little more. While they are not always satisfied with the attachments necessary for good illumination, they secure the best they can, and desire these appliances to match the fixture in finish and glassware. Many of these customers are sent to you by buyers and architects, and they generally invite your aid in making their selections.

In still a third class may be considered that portion of the public which considers candle power and cost of secondary importance and attaches the greatest importance to the decorative and harmonious appearance of the fixtures. The gas appliance man does not, as a rule, come in contact with this class, as these people generally use electricity for lighting and buy principally from the manufacturers, in consultation with their decorators and architects. To them the lighting fixtures must be an ornament, and one that is in absolute accord with their scheme of decoration. They are willing to pay a good price for the fixtures that meet their fancy, but are critical in their selection and exacting in their requirements. There are numerous cases where people of this class have elected to use gas for illuminating purposes, and for them some really beautiful and interesting effects have been produced.

And now having touched upon the history of the case and having analyzed the symptoms, let us proceed to prescribe a remedy.

First—Equip your departments to prop-

erly sell gas fixtures. While this remedy is more applicable in some cases than in others, a majority of appliance departments are not equipped to properly handle this portion of their business. Generally the salesmen are not trained to sell fixtures. It takes years to make a first-class fixture salesman to sell fine goods, yet the selling of gas fixtures is left to clerks, or others equally unfit, who can recite without a pause the advantages and claims for economy regarding gas ranges and water heaters, but who know nothing more regarding a fixture than the information given on the price tag. Such a salesman cannot properly understand a customer's requirements, nor talk intelligently with critical buyers of good things. Train your salesmen to understand and appreciate style and workmanship. Have them interest themselves in the customer's needs and peculiar conditions and let them give that intelligent advice and aid that a customer has the right to expect of you. Remember many of those customers appreciate good fixtures, and while they may not have a clear-cut opinion as to what they especially desire, they are dissatisfied if you do not appear to realize just what a problem the selection of their lighting fixtures is. Encourage them to pay a fair price for something worth having, and, in the words of the familiar saying, "the satisfaction with the quality of the article will remain after the price has been forgotten." Have your samples displayed to the best advantage. A small stock of well selected fixtures, arranged in an attractive manner, is vastly better than a large number of samples crowded together and poorly arranged. To the average customer, nothing is more bewildering than to gaze upon rows and rows of samples and attempt to make a selection. Of course, you are obliged generally to fill orders from stock, and customers desire the display of a number of samples from which to make their selection; but let the method and arrangement of display be one of your first considerations.

Second—Be dignified in your advertising. There seems to be a tendency toward exaggeration in the advertisements of gas appliances that has the effect of lessening the confidence of the public in all gas appliances. While appliance managers are perhaps not directly responsible for this, they can certainly exert a strong influence in the right direction. What would you say, if you saw advertised tomorrow that a new incandescent electric lamp had been put on the market giving 100 candle power for 50 watts of current? It is equally as absurd to expect such an announcement as it would be to credit it. My attention has been repeatedly called to advertisements of electrical appliances, and I noticed particularly one describing a new electric lamp that has been recently put upon the market. The statement is made that it is a 2 watt lamp and should develop 22 candle power, with a consumption of about 44 watts. If you have occasion to purchase this appliance and test it, you are reasonably certain that the figures shown in the advertisement will be verified, and you are much surprised if you find a gross misstatement of facts. On the other hand, in recent popular magazines I have noticed advertisements of gas lamps, which are excellent devices, well made and good sellers, but advertised to give 200 and 300 candle power with a consumption of but a few feet of gas per hour. What would you say if an agent called upon you with the statement that he had a burner that would give 100 candle power to the cubic foot of gas? Wouldn't you sit up and listen if he even said 25 candle power and you could place full confidence in his statement? A short time ago a salesman strolled into my office to show me a new type of gas arc, having four burners for four mantles and a large globe covering the whole cluster. He evidently did not know that he was "bringing coals to Newcastle." I became interested to hear what he would say, and asked him a few questions. "This light is wonderful," he said. "It will give you 1,000 candle power, or as much as an electric arc light." This was truly something startling, and I asked him how much gas it would consume. "About 10 feet an hour," was his reply. Truly this was more startling. I looked over the familiar needle valve, Bunsen tube and mantles, and remarked, that the only novel feature that the appliance seemed to possess was the long length of the Bunsen tubes. "That is what does it," he told me, "only those are not Bunsen tubes, because we make them ourselves." This may be an exceptional case. I hope it is, but it is just such representations that tend to discredit gas for illumination.

Third — Encourage the adoption of smaller and better distributed units of light. A recent editorial in one of the scientific papers on high power light units gives a very interesting opinion on this question.

"That there is a general tendency toward

the using of higher units is plainly evident from the facts. So far as there is genuine competition between gas and electric light, the contest is usually to see who can produce the greatest flood of light for a given expenditure, entirely regardless of the visual and æsthetic qualities ot the illumination produced. The incandescent gas burner, with its fairly dazzling light of 60 rated candle power or more, could only be beaten by a cluster of the standard 16 candle power electric lamps, or the electrical arc. To compete with the latter, the "gas arc" was produced, which was simply a cluster of incandescent mantles. At last accounts, electric lighting had scored a complete victory by the introduction of the flame arc, which has left the gas arc and all other forms of illumination hopelessly behind in the race for garish brilliancy.

"In many respects the contest reminds one of the country band tournament, in which the band that made the most noise won the prize. Increase in light power by closely clustering small light units, has usually and rightfully been condemned by illuminating engineers; and the most serious fault of the arc lamp has been its necessarily high light-power as well as high intrinsic brilliancy.

"There are doubtless many cases where multiple lights, either in clusters or in chandeliers, can be very advantageously replaced with the more efficient units that are coming into use, but the ordinary dwelling house certainly does not afford such a case. While the general race of each to outshine his neighbor is interesting along "the Great White Way," there are few who wish to carry the contest into their private apartments; the rest and eye comfort resulting from a soft and comparatively low intensity of illumination are still demanded for the home. The chandelier with multiple lights, or the cluster, has the advantage of affording a variable illumination, and on this account alone must always take precedence over the single unit of high power for private lighting."

I do not intend to unduly criticize the gas arc in this statement, although prominent gas company men have expressed thier disapproval of its general use, and a few years ago the American Gas Light Association had a lengthy discussion on this point. I do intend to criticize the use of powerful burners on a single arm of a chandelier or bracket. The only thing this method of lighting has in its favor is that it is cheap. It does not give good illumination, it is bad for the eyes and it is artistically barbarous. What is needed is a scattering of smaller units, thereby producing a better illumination, and at the same time an attractive appliance for lighting. Personally, I am a strong believer in the miniature mantle, such as No. 63 Welsbach. This little mantle gives much more candle power than a standard electric lamp and is the size used very generally by one of the largest makers of burners and appliances for gasoline gas in the country. I shall be very glad to see a mantle and burner put on the market of a size between this and the usual standard, something about the size of the No. 2 Kern mantle, that would give 50 to 60 candle power with about 3 feet of gas. Such a mantle could be used with standard electric glassware and would be a very useful size for fixture purposes. Regarding the inverted type of burner, I can only say that we are watching its development with much interest. In Mr. Lansingh's paper, to which I have already referred, he says:

"There are, of course, many disadvantages today with the inverted burner, chief of which must be reckoned the discoloration of fixtures, and it would seem that the gas engineer has a fruitful field in getting fixture houses to design a line of fixtures which are especially suitable for the inverted type. Even the question of finish is important, as the ordinary brush brass or polished brass fixture tarnishes very quickly with the heat. If, on the other hand, finishes such as verde antique or other dark finishes, were used on both burner and fixture, the discoloration would show very much less. Of course, in many cases such finishes would not be suitable, but where they can be used, it will do away largely with this serious objection. The attempt to adopt the inverted burner to the present type of fixture is generally unsatisfactory, but it should be an easy matter to design fixtures which will be suitable for the inverted type, so that it will be available in many places where not suitable at present."

These suggestions regarding fixture construction can be carried out if conditions warrant the expenditure of the necessary time and money, and I trust that I may hear an expression of opinion from you on the question.

Fourth—Raise the standard of the appliance, and especially of the fixture that you sell. Too often, sad to say, the buyer of fixtures knows little of style or artistic value, and not much more of good work-

manship. His standard seems to be, so much brass for so much money; and the manufacturer, striving to maintain a reputation for well made and really good fixtures, well finished and artistic, is turned down for the smaller maker, who buys stock, castings, shells and other metal work, employs cheap and inferior help and makes a mongrel design at a few cents lower price. These manufacturers receive very little encouragement in their attempt to elevate the gas lighting fixture and thereby the whole tone of gas lighting. Of the appliances that you carry, let your ranges and water heaters be well made, efficient and economical; let your mantles be good and reliable; let your burners and other attachments be well made, efficient and as attractive as they can be procured, but above all, let your fixtures be well selected, well made and attractive. These appliances, more than anything else you handle, should be both instruments of usefulness and of decoration.

Incandescent Lamp Tests on Alternating Currents

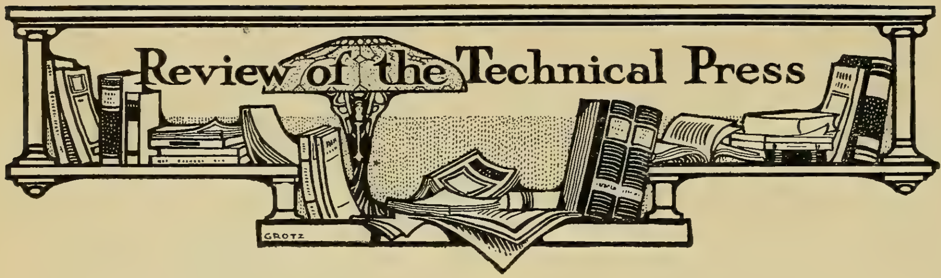
At a meeting of the Institution of Electrical Engineers on Feb. 7, Dr. H. F. Haworth gave the results of some comparative life tests on carbon, Nernst, and tantalum incandescent lamps to determine whether the working of such lamps on an alternating-current circuit was in any degree different from that when using continuous current. A series of tests were undertaken by Dr. Haworth, Mr. T. H. Matthewman, and Mr. D. H. Ogley, and the results of these tests were embodied in the paper presented on the same evening by Dr. Haworth. Owing, however, to the prolongation of the discussion on Mr. Clifford Paterson's paper, time would not permit the reading of the other paper in detail, and Dr. Haworth merely presented a very brief abstract. He gave an account of the apparatus specially designed and made for these tests, in order to keep the voltage automatically constant on alternating-current circuits. The chief feature of excellence in connection with the voltage regulator described seemed to be that it could regulate, under the best conditions, to plus or minus ⅛ per cent., or, under normal conditions, to plus or minus ¼ per cent. Tables were presented showing the performances under test of the Nernst and carbon incandescent lamps, and a comparison of the average results shows a saving of 57 per cent. in watts per candle in favor of the Nernst lamp. The percentage cost saving is much less than the percentage energy saving on account of the frequent and expensive renewal of glowers and iron resistances. Against the saving in cost the authors placed (1) the much higher capital outlay on the lamp; (2) the large sizes in which it is manufactured; (3) the time it takes to light; (4) the erratic life of the glowers. It must be remembered that these tests are made with alternating currents, and that the Nernst lamp appears to work much better with continuous current. Further tests were divided into three series: (1) Lamps run on their constant normal voltage (230); duration of test, 1,000 hours. (2) Lamps run on a constant voltage (240), about 5 per cent. above normal; duration of test, 750 hours. (3) Lamps run on a voltage varying continually between 230 and 240 volts, the variation having a period of two minutes. In the first series of tests six lamps, three 16 c.p. and three 32 c.p., of each kind were tested, except tantalum lamps, in which case two 115-volt lamps were placed in series. The Nernst lamps used were 245 volts, 0.25 ampere. The Nernst lamps were marked 225 volts on the filament and 20 on the ballasting resistance, so that it would appear that they should be run on 245 volts, and it was found that they gave better results on the 240 than on the 230 volt circuit, yet they were the lamps sold for use on the 230-volt mains at Liverpool. In the second and third series of tests two lamps, one 16 c.p. and one 32 c.p., of each make were employed. In all cases the frequency of supply was 50. The general conclusions were as follows: The average of "the average watts per candle" for the 70 carbon lamps tested in all is 4.86; for the eight ¼-ampere Nernst lamps tested this average is 4.14, and for the six tantalum lamps 1.97. The ordinary ¼-ampere Nernst lamp of commerce is thus about 15 per cent. better than the average carbon lamp, while its life is about 560 hours. The average consumption of the tantalum lamps tested was 60 per cent. less than that of the carbon lamps, and their lives were on the average 330 hours; doubtless the tantalum lamps made now will give much longer lives than these. Though the tantalum lamps, even on these few tests, show a much better efficiency than the carbon lamps, the makers of carbon lamps—feeling the competition of the new metal-filament lamps—will, without doubt, vigorously turn their attention to the production of a two-watt-per-candle carbon lamp.

Observations on Light Standards

By A. G. Vernon-Harcourt.

(Discussion of Mr. Paterson's Paper.)

The knowledge that atmospheric conditions have important influences on the candle-power of flame standards is not quite recent. It must have been present to the minds of all who have thought out and arranged these standards, though an accurate determination of the correction to be applied for such atmospheric variations as were material, was no easy task. For the approximate measurement of the light of flames such as that of an oil-lamp or a gas-burner, the probability that the standard flame and that whose light it was used to measure would be similarly effected by atmospheric variations, was sufficient to make the correction of each unnecessary. When, however, a flame standard was to be used for standardizing glow-lamps, the corrections to be applied must be determined; and Dr. Liebenthal and Mr. Paterson had not, he thought, discovered an error, but had done an essential service which few had such good means of doing, in making these determinations. In the year 1885, he (the writer) examined the influence on the one-candle standard, which he had proposed, of variations in atmospheric pressure, by comparing it with a small glow-lamp, the current of which was adjusted by means of an electro-dynamometer. He found that the pentane flame, which gave a light of one candle when its height was 63.5 mm. and the atmospheric pressure was 760 mm. must be raised or lowered in inverse proportion to the rise and fall of the barometer for its light to be constant. His experiments upon the influence of atmospheric moisture began earlier—in 1879. He had then no glow-lamp for measurement, and only by the help of his one-candle flame compared the light given by a stored sample of coal-gas, burning from a "London" argand burner in a box photometer when the air was dried and undried. Trays of quicklime were placed beneath the opening at the bottom of the box, and the light was 16.6 candles; the trays of lime were removed, and the light was 15.9 candles. Another day the gas was tested, and the yield of light was found to be 16.2 candles. The trays were then filled with slightly warm water, and the light was 15.4 candles; the trays were removed, and the light was 15.85 candles. Many such observations were made; but the attempts to measure the humidity with wet and dry bulb thermometers were unsatisfactory. It was certainly very difficult to treat the air in any way without interfering with its free flow, and thus affecting the light of the burner. He agreed with Mr. Paterson that it was best to wait for natural variations. There was still another atmospheric condition not named by Mr. Paterson, whose effect he hoped Mr. Paterson would investigate—viz., temperature. By the variation of this condition, the flame standard and the glow-lamp were both, however unequally, affected. A 10-candle gas-lamp was placed in the center of a cylinder, 18 inches in diameter and 20 inches in height (within which was a long coil of metal pipe, through which hot or cold water could be run), lined inside with black cloth. An 8-inch opening in its lid gave free passage to the air. Two small lateral openings served for the beam to be measured and for observation of the flame. At temperatures of 36°, 32°, 29°, and 24°, the light was 10.6, 10.4, 10.3, and 10.2 candles. The temperature of flame was far removed from that of the air; but the principle of the hot blast came in, and particles of carbon were measurably brighter at, say, 1510° than at 1500°. That the glass envelope of a glow-lamp was hotter on a warm day was certain. The exchange of temperature between it and the filament through a nearly vacuous space, shown by the warmth which the glass maintained, though continually cooled by the air around it, must be much slower than that which was due to the free and rapid access of air to a flame. Was the effect of the temperature of the air around on the light of a glow-lamp measurable or not? If the answer was not already known, it could easily be obtained by experiment. Since, when the air was warmer, the proportion of steam in it was generally greater, and since the light of a flame was increased by warmth and diminished by a greater proportion of steam, these simultaneous variations must to some extent balance one another. But that which was needed, and which had already been partly supplied by Mr. Paterson, was a formula for correcting the photometric results obtained on comparing a glow-lamp with a particular flame standard, by which allowance would be made for the variations of pressure, temperature, and moisture, much as the observed volume of a gas measured over water was now corrected for these same variations.



American Items

Electrical Illumination of Show Window Displays: W. H. Stuart, *Electrical World,* March 2nd.

A short article describing a few good and bad examples of show window lighting.

Ornamental Lamp-posts and Special Lighting of St. Paul Business Streets: Illustrated, *Electrical World,* March 2nd.

A statement of what has been accomplished by merchants "Improvement Associations" in the way of decorative street lighting in St. Paul.

Experiments with Magnetite Arc Lamps in Harrisburg, Pa.: Illustrated, *Electrical World,* March 2nd.

An article giving the results of this method of street lighting with various items of cost of maintenance.

Arc Lamps for Train Lighting: *Railway and Engineering Review,* February 23rd.

A brief description of a new system of electric train lighting which is being tested on the Chicago & Northwestern Railway.

Illumination in the Boston Herald Building: Geo. W. Martin, *Western Electrician,* March 2nd. Illustrated. The illumination throughout is by enclosed arc lamps with diffusing reflectors.

The Bulletin.

This is the title of a four-page sheet published for sixteen different gas and electric companies, in which H. L. Dougherty is the moving spirit. The fact that this Bulletin is published daily would alone make it remarkable, and we believe unique, among such publications of its class. It is devoid of advertising, and devoted to various items of news and suggestions which tend to promote the welfare of the lighting companies. It is plainly evident that the "square deal" is the basis upon which these companies work, and that it is the particular aim of this little "Daily" to establish this fact among their various consumers.

The Arc as a Source of Light: Elihu Thompson, *Electrical Review,* March 9th.

A brief but most excellent review of the development of the arc light by this well-known authority.

An Electric Light Retrospect and a Prophesy: W. W. Freeman, *Electrical Review,* March 9th.

From the brief "retrospect," the writer comes to the following conclusion: "It is the deliberate opinion of the writer that the commercial development of recent years is but an introduction to a proper realization of the application of electric service of the everyday needs of the public, and that the industry has reached the threshold of a near-future growth hitherto unrealized, but the benefits of which every company can share through their aggressive intelligence and systematic effort."

Electric Lighting by Incandescents: Wm. J. Hammer, *Electrical Review,* March 9th. Illustrated by cuts of the Hammer collection of incandescent lamps.

The article traces the development of incandescent lamps from its earliest days to the present time. The fact that the writer has made a special study of this subject, and has gathered one of the most remarkable collections showing "the history of an art," is a sufficient comment upon the value of the present article.

Tables for the Computation of Illuminations Compiled and published by Wm. B. King, Dorchester, Mass. $2.00, postpaid.

The author states that "these tables are designed to give the values of the illumination upon plane surfaces, and also the amount of light necessary to give any intensity of illumination upon such surfaces without any computation except simple multiplication. They can be used with any system of units of distance, light and illumination, and all mention of units has therefore been purposely left out of the

tables." Besides the tables, full and explicit directions are given for their use, and of the various formulæ ordinarily used by illuminating engineers. While the price of the book is high, judged simply from the amount of matter contained, it will save its cost many times over to those who find it necessary to compute illumination for practical or theoretical work.

The book contains forty tables, covering all ordinary heights at which ight-sources are placed. The second column of each table gives the horizontal illumination of a source of "unity" at a height indicated by the bold figure at the top of that table, at the angles stated in the first column. Rays from this source, at these angles, strike the surface at distances from the foot of the perpendicular stated in the third column. The last column gives the light required for "unit" illumination. By multiplying the candle-power of any light by the value in the second column, the illumination is very rapidly obtained. Likewise, by multiplying the last column by the illumination wanted, the needed candle-power is also obtained.

Perhaps the most useful features of these tables is the last column, which gives the candle-power required to give a horizontal illumination of one foot-candle. The computing can be done on a slide rule, from this column alone, using the law that the illumination from two lights (at the same distance and angle) is in proportion to their respective candle-powers. By setting the candle-power required for an illumination of one foot-candle (taken from the tables at the distance and angle desired) over the figure "one," values of the illumination with any candle-power, or the candle-power required for any illumination, can be read off directly. In working by this method, the actual values are read off directly and no multiplying factor enters into the computation to confuse the mind in regard to the position of the decimal point.

The Luminous Equivalent of Radiation

By P. G. Nutting.

From Physical Review, Feb.

The visual response to radiation depends upon the intensity and quality of the radiation and the time during which it is operative, as well as upon various subjective conditions. Some function of energy and wave-length is therefore necessary in order to translate radiation into light or visual brightness, that is, to make possible a purely physical definition of light. The construction of this and subsidiary functions is the subject of this discussion.

The problem is essentially one of determining the properties of the eye as a physical instrument, as a species of radiometer. It is necessary to relate the indications of this instrument to the quality and intensity of the incident radiation, in order to translate exciting stimulus (radiation) into scale reading (light).

The same amounts of radiation in watts per unit wave-length in different parts of the spectrum, affect the eye in different degrees. Hence, other things being equal, the sensibility of the eye is a function of the wave-length, say $V(\lambda)$, call this *visibility* of the radiation. For any arbitrary spectral distribution of radiation $E(\lambda)$ then, the product EV will give a third function of wave-length, say $L(\lambda)$, which we may call the *luminosity* or optical intensity of the radiation. The determination of the visibility function $V(\lambda)$ is the first step toward the solution of the general problem.

Again, the sensibility of the eye varies with the intensity of the incident light. In range, the eye is comparable with an ammeter capable of registering millions of amperes and milliamperes as well. With increase of intensity the sensibility decreases according to some function $S(L)$ of the luminosity. This sensibility function $S(L)$ may be derived from data on the photometric constant and includes Fechner's law as a special case.

Now the sensibility of any instrument at any particular value of the exciting stimulus is the derivative of a scale reading with respect to exciting stimulus. Hence, once $S(L)$ is determined, the *visual brightness* function $B(L)$ is determined by the general integral of SdL. This brightness function $B(L)$ *or* $B(E,\lambda)$ is the one ultimately desired.

One might proceed further with the sensibility of the eye for differences in wave-length, thus dissecting $V(\lambda)$ into three or more components $V_1(\lambda)$, $V_2(\lambda)$, $V_3(\lambda)$, . . ., but this has little physical significance except in determining the whiteness of light.

The surface integral of the spectral integral of $E(\lambda)$ is evidently the total energy emitted by a source. Similarly the same integrals of $L(\lambda)$ is the total light emitted. This light integral, tempered or not, according to whiteness, is what possesses commercial value in illumination. The ratio of the light integral to the energy integral is the *luminous efficiency* of a source.

THE VISIBILITY FUNCTION.

The visibility function gives the relative sensibility of the eye to radiation of different wave-lengths. It is by definition ($L \equiv EV$) the ratio of visual intensity L to energy intensity E. It may be determined (a) by taking the reciprocal of the threshold value E_0, *or* (b) from the luminosity, determined visually, of a source whose energy curve is known. The identity of visibility with reciprocal threshold value will appear later in the discussion of sensibility as a function of intensity, and is abundantly confirmed by experiment.

Langley[1] measured the least energy by which it was necessary to illuminate a logarithm table to make it legible. A. König[2] determined threshold value and luminosity at both high and low intensity. Pflüger[3] measured threshold value with a thermopile. In all, about fifty sets of experimental data on visibility are available. All show a pronounced maximum in the green, a rapid falling off toward blue and red to a very small but finite value in the extreme red and violet.

The position of the maximum of visibility at low intensity varies somewhat with the individual, but the mean of the forty used by the writer[4] is at 510 $\mu\mu$. The maximum lies between 500 and 520 for nine out of every ten individuals. Eleven curves from the best data of Langley and König reduced to the same maximum ordinate are reproduced in Fig. 1. All but two of the remaining curves would have fallen within this same galaxy but could not be reproduced without crowding the figure.

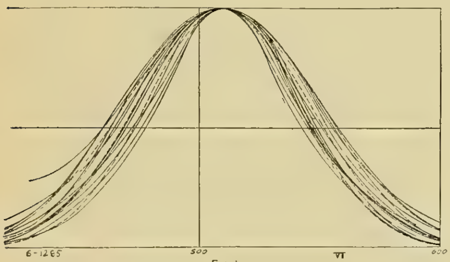


Fig. 1.

The physical problem does not require a special function that will closely represent each individual curve. What is required is a single general function of the simplest possible form and with fixed mean parameters that will represent the properties of the average human eye as closely as any other function that might be constructed. Special work will always require a special investigation of the properties of the observer's eye at the time he is working. General problems of illumination, however, require the specification of the properties of a mean average standard eye.

From the observed data it appears that the mean visibility curve $V(\lambda)$ is very nearly if not quite symmetrical and similar to the probability curve in form. The dotted curves in the figure are the plotted values of the probability function.

$$V = V_1 e^{-a(\lambda-\lambda_m)^2}$$

with $\lambda_m \equiv 5.10$ s.-m. ($= 510\ \mu\mu$) and $a = \pi$, 4 and 5. The parameter four represents the mean value very closely. The parameter π would have the advantage of giving the curve unit area per unit maximum ordinate but is obviously too small.

The sole condition thus far imposed upon the parameters V_1, a and λ_m is that they are not functions of wave-length. V_1 depends upon the unit of luminosity chosen; a decreases and λ_m increases somewhat with increase of intensity. The values given, $a = 4$ and $\lambda_m = 5.1$ s.-m., refer to very low intensities approaching the threshold value. The mean visibility curve for low intensities is practically the same for all individuals, being sensibly independent in both form and position of color blindness, partial or complete, and of the absolute sensibility of the individual eye.

The visibility function at high intensities, however, varies considerably in cases of partial color blindness. For normal eyes, the only data is that of König, on his own and one other eye. The curves are broader than those at low intensity, and displaced toward the red. The visibility function given fits them fairly well for $a = 2$ and $\lambda_m = 5.6$. With such scant data, however, these values cannot be regarded as established. The shift of the maximum with intensity may easily be demonstrated by means of a small grating spectograph and sunlight. As the slit is opened the maximum of brightness is seen to move over from deep green toward the yellow.

Another method of obtaining the variation of a and λ_m with intensity suggests itself. Suppose the threshold value of the luminosity L_0 is determined, as was done by

[1] S. P. Langley, Energy and Vision, Am. Jour. Sci., 36, 359-380, 1888.

[2] A. König and C. Dieterici, Z. Psy., Phys. d. Sinnesorgane, 4, 241-348, 1893.

[3] A. Pflüger, Ann. d. Physik, 9, 185-208, 1902.

[4] A more extended treatment of this subject with full quotations of all data used is to appear in the Bulletin of the Bureau of Standards.

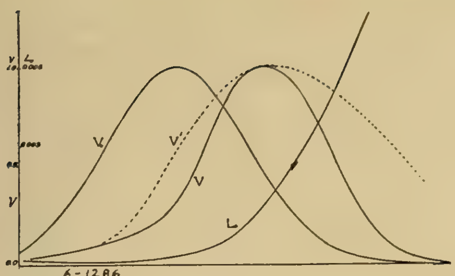


Fig. 2.

König and Brodhun,[1] in terms of a rather large light unit, say one meter-candle. If now the visibility function $V(\lambda)$ for the higher intensity were identified with that $V_0(\lambda)$ at low intensity, $L_0(\lambda)$ would be constant. In any case $L_0 = V : V_0$.

In Fig. 2 are shown König's values of L_0, the visibility curve V_0 for $a = 4$ and $\lambda_m = 5.1$ together with the curve L given by the product V_0L_0 at each wave length. The curve V' is that obtained by König from luminosity and energy at high intensity, but is subject to a large and uncertain correction for the spectral energy variations. It has the same maximum but is much broader than the calculated visibility curve.

Calculating L_0 as the ratio $V : V_0$

$$L_0 = e^{-2(\lambda-5.6)^2} : e^{-4(\lambda-5.1)^2} = e^{2(\lambda-4.6)^2},$$

a curve of the same general form as that obtained directly from König's data. The values $a = 2$ and $\lambda_m = 5.6$ for the parameters of the visibility function at high intensities cannot be regarded as established on the scant data at present available, much less can the general functions $a(E)$ and $\lambda_m(E)$ be determined as would be required for a complete solution of the general problem.

VISUAL BRIGHTNESS.

The eye will always underestimate actual differences in intensity, other things being equal, on account of the decrease in sensibility with increase in intensity. But since the magnitude of a sensation can be estimated only with the roughest approximation, indirect methods must be resorted to in order to determine the brightness function of luminosity $B(L)$. The most accurate data in this field is that relating to photometric sensibility and to persistence of vision.

Photometric sensibility is generally given as the ratio of the least perceptible increment to the total luminosity, $\delta L : L$. Call this $P(L)$. Measured in terms of a fixed unit of luminosity this increment would be LP. But sensibility is, properly speaking, the inverse of this, since the least perceptible increment is greater as sensibility is less. Sensibility to luminosity is then proportional to $1/PL$. Now the sensibility of an instrument at any part of the scale is the derivative of the scale reading with respect to the stimulus measured, so that $S = dB : dL$. If then P can be determined as a function of L, B may be established.

König and Brodhun's data[1] on photometric sensibility is very complete for six different wave-lengths and intensities ranging from 0.01 to 100,000 m.-c. This data is shown graphically in Fig. 3, where $\delta L : L$ is plotted against log nat. L. The dotted ordinates represent threshold values (L_0) of the luminosity. Since at the threshold value, the least perceptible light is the whole, $\delta L : L$ must there approach unity in value. The observed curves have been extrapolated to that value. At high intensities all the curves approach the same minimum constant value

$$P_m = 0.016.$$

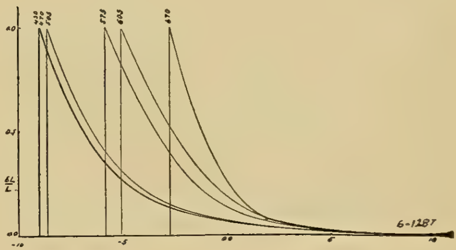


Fig. 3

Had the threshold value L_0 been used in each case as a unit of luminosity instead of a much larger common unit, all curves would be shifted to a common dotted ordinate and, except the extreme red curve, would become congruent to far within the error of observation.

This form of curve may be represented by the simple function

$$P = a + be^{-cx},$$

where $x = \log (L : L_0)$, $a = P_m = 0.0016$, $b = 1 - P_m = 0.984$ and $bc = 0.26 \pm 0.01$ (read from a large plot) when x is in natural logarithms. This would give for $P(L)$

$$P = P_m + (1 - P_m)(L_0 : L)^c.$$

Taking $S = 1/PL$

[1] König and Brodhun, Sitz. Ak. Berlin, July 26, 1888.

$$S = \frac{1}{L(P_m + (1 - P_m)(L_0 : L)^c)}$$

hence $B =$

$$\int S dL = \frac{1}{P_m c} \log (1 + P_m(L^c - L_0^c)),$$

the integration constant being zero, since visual brightness must be zero for $L = L_0$ at the threshold value.

This gives then for the final form of the brightness function

$$B = B_0 \log (1 + P_m(L^c - L_0^c)).$$

or at moderate and large intensities, the simple form

$$B = a \log L + b.$$

Had we chosen a different variable T by which to measure the visual sensation, such that $B : B_0 = \log T$, we should have for moderate and large intensities

$$L = kT^4,$$

a very simple and suggestive relation.

The Purkinje Phenomenon is implied in several of the relations given above. Mathematically considered, this phenomenon involves the rate of change of luminosity or of visual brightness with energy. This should be greater for red and yellow than for blue and green. However, it is demonstrated, the phenomenon rests ultimately upon the variation, $V(E)$, of visibility with intensity. If this variation did not exist there could be no Purknje or other allied phenomenon.

The simplest demonstration is given by the ratio of two luminosities $L = EV$ and $L_0 = E_0V_0$, the latter of which is very small.

Then

$$\frac{L}{L_0} = \frac{E}{E_0} \frac{V}{V_0}.$$

But $V : V_0$ is always greater for red than for blue and green light (see Fig. 2), since the parameter a decreases and λ_m increases continuously with increase in E. Hence a given variation in E will produce a much larger variation in L in the red than in the blue or green, judging by the data of Fig. 2, it might in some cases be 50 or 100 times as great. Taking instead of $L : L_0$, $dL : dE$ or $dB : dE$ leads after substitution to the same result.

Fechner's Law.—Fechner's law states that to produce a constant increment to a sensation requires a constant percentage increment to the stimulus. In this case the law will give $\delta L : L =$ const., where δL is the least perceptible luminous increment. For moderate and high intensities, this constant is about 0.016. But at the threshold of vision, evidently the least perceptible increment is the whole, hence $\delta L : L$ approaches the value of unity and Fechner's law $\delta L : L =$ const. cannot hold at these low intensities.

To extend Fechner's law to cover these low intensities we must consider $\delta L : L = P$, the general photometric function discussed above. Hence, if the function $P(L)$ there constructed be correct, the complete form of Fechner's law is

$$\frac{\delta L}{L} = P_m + (1 - P_m)\left(\frac{L_0}{L}\right)^c$$

which is the simple general form

$$\frac{\delta S}{S} = a + bL^{-c}$$

THE TIME FUNCTION.

Upon visual brightness as a function $B(t)$, of the time, depend persistence of vision and other allied phenomena. Since data in this field is of considerable accuracy and obtained with the simplest apparatus, a function relating brightness to a time is of great interest.

$B(t)$ we know to be of the general form shown in Fig. 4, starting at zero, increasing rapidly at first and then less rapidly, and reaching a constant value after a short time.

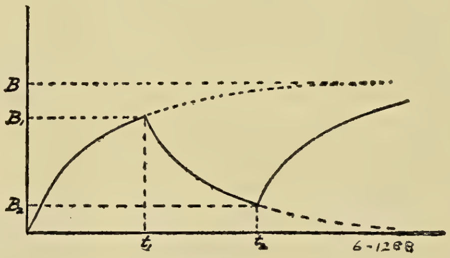


Fig. 4.

$$B(t) = B(1 - e^{-at})$$

satisfies these conditions.

If now the eye be illuminated by light passing through a rotating sectored disk, $B(t)$ will be cut off after a time p_1, and again renewed after a further interval p_2 and so on. Let B_1 be the value attained by $B(t)$ after a period p_1, and B_2 the value if screened for a time p_2 after having attained the value B_1. Then

$$B_1 = B(1 - e^{-a_1 p_1})$$

$$B_2 = B_1 e^{-a_2 p_2}.$$

If the speed of the sector be varied until the sensation of flicker just vanishes, obviously

$$B_1 - B_2 = PL$$

the photometric constant measured as an absolute increment of luminosity. But

$$B_1 - B_2 = B(1 - e^{-a_1 p_1})(1 - e^{-a_2 p_2})$$

$$= B(1 - e^{-ap})^2$$

if $a_1 p_1 = a_2 p_2 \equiv ap$, that is, if the segments cut from the disk equal those remaining, and if initial rate of growth equals rate of decay of visual impressions. Hence, under these conditions

$$PL = B(1 - e^{a-p})^2$$

In the preceding work both P and B have been set up as functions of L and certain constants. Hence if L is a constant in any variation of conditions (say wave-length) tne critical frequency, p, must be constant as observed by Ferry.[1]

Substituting the values of P and B found above

$$(1 - e^{a-p})^2 = \frac{PL}{B} = \frac{P_m L + L_0^c(1 - P_m)L^{1-c}}{B_0 \log(1 + P_m(L^c - L_0^c))}$$

a form rather too complex to be useful as it stands. But the quantity in parentheses is small, so that its expansion in power series converges very rapidly. Further, the right-hand member at moderate and high intensities is approximately proportional to $L/(\log L + a)$, hence

$$a^2 p^2 = k \frac{L}{\log L + a}$$

is an approximate form of the above.

LUMINOUS EFFICIENCY.

It is the spectral integral of luminosity L to which the illuminating power and hence the commercial value of radiation is proportional. It may be well here to summarize the relations subsisting between these quantities and luminous efficiency.

Suppose the spectral *energy* $E(\lambda)$ of the radiation be given in watts per s.-m. per unit solid angle ω. From this suppose the spectral *luminosity* $L(\lambda)$ derived in arbitrary units (say *lumens*) per s.-m. per unit solid angle by means of the sub-idiary visibility function $V(\lambda)$. Then

Specific Emission. $= \int_0^\infty E d\lambda$ in watts per unit solid angle

Total Emission $= \int_0 d\omega \int_0^\infty E d\lambda$ in watts.

Specific Illumination $= \int_0^\infty L d\lambda$ in lumens per unit solid angle

Total Illumination $= \int_0 d\omega \int_0^\infty L d\lambda$ in lumens.

$$\text{Luminous Efficiency} = \frac{\text{total illumination}}{\text{total emission}}$$

= etc., lumens per watt.

Since the space distribution of radiation and illumination must be identical, the space integrals may be dropped in calculating efficiency. And since $L = EV$.

$$\text{Luminous efficiency} = \frac{\int_0^\infty EV d\lambda}{\int_0^\infty E d\lambda}$$

the numerical value of which therefore depends upon the unit V_1 of visibility adopted in $V = V_1 e^{-a(\lambda - \lambda_m)^2}$ for $\lambda = \lambda_m$. This is the value assigned to the luminosity when the radiation is one watt per unit wave-length at $\lambda \equiv \lambda_m$.

Luminosity and Temperature.—If the spectral energy $E(\lambda)$ is known in functional form, say the Wien function, taking $V(\lambda)$ as derived gives the luminosity $L(\lambda)$ in terms of wave-length and certain parameters including temperature. The total luminosity then, which is the definite integral of $L d\lambda$, is in the form of a function of these parameters. Unfortunately the Wien function itself leads to a form

$$L = EV = C_1 V_1 \lambda^{-5} e^{-c_2/\lambda T - a(\lambda - \lambda_m)^2}$$

which is very difficult or impossible to integrate. Once the integral of $L d\lambda$ is obtained, visual brightness follows as a linear function of the logarithm of this integral.

Quality of Illumination.—Light is "white" when (a) $E(\lambda)$ = constant and (b) light of three or more colors is combined in certain proportions. According to the most widely accepted theories of color vision, the visibility curve $V(\lambda)$ is a composite of three elementary visibility curves such that

$$V = V_1 + V_2 + V_3.$$

These elementary curves appear to be indeterminate at present chiefly because there are more variables to be determined than equations to determine them. By assuming them of equal area (König and Dieterici) or equal maximum ordinate or of exactly

[1] E. S. Ferry, Am. J. Sc., 44, 192-207, 1892.

the same form they may be deduced by means of the observed sensibility of the eye to slight color differences. Assuming them to be known, and taking $L_1 = EV_1$, etc., evidently the criterion for white light is that

$$\int L_1 d\lambda : \int L_2 d\lambda : \int L_3 d\lambda = \int V_1 d\lambda : \int V_2 d\lambda : \int V_3 d\lambda$$

whatever the form of the spectral energy curve $E(\lambda)$.

SUMMARY.

1. Radiation $E(\lambda)$ may be translated into light $L(\lambda)$ by means of the relation $L = EV$ where $V(\lambda)$ is the visibility function of the simple form

$$V = V_1 e^{-a(\lambda-\lambda_m)^2}.$$

The parameter V_1 is arbitrary while for low intensities $a = 4$ and $\lambda_m = 51$ s.-m. a decreases and λ_m increases steadily with increasing intensity, reaching the values $a = 2$ and $\lambda_m = 5.6$ at an intensity of about 100 m. c.

2. The least perceptible percentage differences in luminosity to which the eye is susceptible is closely represented by the function

$$P(L) = P_m + (1 - P_m)(L_0 : L)^c,$$

where $P_m \doteq 0.016$ and $c \doteq 0.26$ and L_0 is the threshold value of the luminosity. P_m and c are nearly if not quite independent of the individual and of the color.

3. Fechner's law $\delta L : L =$ constant, holding for moderate and high intensities, may be extended to cover low intensities as well if written in the form

$$\frac{\delta L}{L} = P_m + \frac{1 - P_m}{(L : L_0)^c}.$$

4. Visual brightness or apparent luminosity appears to be a function of the form

$$B = B_0 \log (1 + P_m(L^c - L_0^c)),$$

No attempt has been made to derive these functions analytically from physiological data; such attempts would but obscure the points at issue. And as the methods of synthetic function theory are as yet largely those of cut-and-try, the functions here obtained are little more than tentative at best. tSill they are vastly more than empirical formulae and of more value than any equations derived from largely hypothetical physiological data.

My object has been not so much to arrive at the final form of these iunctions as to show the essential relations between them. When better data, covering a wider range and more individuals has been obtained, the fundamental functions and their parameters may be more firmly established.

Bureau of Standards,
Washington, D. C.,
November, 1906.

Foreign Items

The Standard Specifications for Carbon Glow Lamps: A Criticism

By Lancelot W. Wild.

From The Electrical Review, London, February 15.

After more than a year of incubation, the standard glow lamp specification has at length been hatched. Under these circumstances, a criticism from one who has not only been accustomed to draw up glow lamp specifications, but has also been constantly engaged in the more difficult task of seeing that they are carried out, will, I hope, not be taken amiss.

Clause 8 provides that the lamp caps shall be tested for insulation resistance at the manufacturer's works. The insulation resistance required is 1,000 megohms between the filament and cap.

I frequently find that lamp caps have a very low insulation resistance initially, if tested quickly and at a low voltage. The leakage, however, very quickly disappears if the test is prolonged, and the higher the voltage, the quicker the change. I have frequently found the insulation of caps to go from 0 to infinity, when tested with an Evershed ohmmeter, in less than 10 seconds. It appears to me, therefore, that the voltage and duration of the test should have been specified.

Clause 9 provides that the test for vacuum shall be the vacuum test employed at the works of the manufacturer. This means, I take it, that the manufacturer can make any test he likes and translate the result how he likes. It would appear that the Committee have been unable to arrive at any standard method of measuring vacuum. Under these circumstances, I

think that it would have been better if the matter of vacuum had been omitted from the specification.

Clause 10 provides that 5 per cent. of the total bulk of lamps shall be tested for rating. The lamps are to be tested for mean horizontal candle-power, watts and inefficiency. Ninety per cent. of the selected lamps are required to fall between certain limits of candle-power, consumption and inefficiency. As the measurement of light value is to be given in terms of mean horizontal candle-power, instead of mean spherical candle-power, which is the only true measure of the total light emitted, it follows that filaments of different form will be in reality differently rated.

As regards the limits proposed, they are reasonable enough, so long as the manufacturer can find a market elsewhere for his outfalls. If, however, the specification were to become universal, either the manufacturer would have to scrap about half his lamps, or else, which is perhaps possible, he might find a way of making his lamps come out to the voltage intended, thus doing away with the present method of sorting. If this should be the result, the specification would prove a real blessing.

Clause 11 provides that 5 per cent. (never less than five lamps) shall undergo a species of life test. The lamps are to be run on a pressure not varying more than ½ per cent. This appears to be reasonable enough, although it would be better still if it could be found practicable to narrow this limit still further.

The lamps selected are to be run not at their marked voltage, but to start at some standard inefficiency. This is an ideal condition if the object of the test is to ascertain the quality of the filament, quite apart from its rating. The advantage gained by running at standard inefficiency is, however, more than neutralized by the fact that the test is terminated, not when the candle-power has dropped to 80 per cent. of its original value, but when the candle-power has dropped to 80 per cent. of its standard value. Thus a lamp starting at 16 c.-p. may drop to 80 per cent. of this, whereas a lamp starting at 16.5 c.-p. is allowed a much larger drop of candle-power, although both lamps are started at the same inefficiency. Now the lamp is judged by the so-called useful life, and the average candle-power hours obtained during this life. At the point of cut-off, that is, when the candle-power has dropped to about 80 per cent., the slope of the candle-power life curve is commonly such that a change of life of 10 per cent. is accompanied by a change of candle-power of about 1½ per cent. If, therefore, a lamp starts at 1½ per cent. above its standard candle-power, the useful life as specified is extended by about 10 per cent., and likewise the lamps that starts 1½ per cent. low in candle-power is robbed of 10 per cent. of its life. Moreover, an error of 1½ per cent. in the last candle-power measurement also makes a difference of 10 per cent. plus or minus to the life of the lamp. As 10 per cent. variation of life is all that is permitted by the specification, it follows that the passing or rejecting of a large batch of lamps will depend quite as much upon the judgment of the testing authority in selecting the lamps to be tested, and also upon the accuracy of the final measurements of candle-power, as upon the merits of the lamp filaments.

This, however, is not the worst point about these life tests. There is an even larger source of error brought in by the fact that the lamps are judged by their mean horizontal candle power, rather than by their mean spherical or true candle-power.

The reduction factor or ratio of mean spherical to mean horizontal candle-power varies in lamps of different manufacture from .8 to .9. These are extreme limits, I admit, but I have found them actually occurring fairly frequently.

Now, suppose we have two high-voltage lamps, each giving 16 mean horizontal candle-power and each consuming 3.7 watts per mean horizontal candle-power. Let one of these lamps have a reduction factor of .8 and the other .9, then their mean spherical candle-powers will be 12.8 and 14.4 respectively, and their true inefficiencies 4.63 and 4.12 watts per candle-power respectively. Now supposing that the filaments of both lamps are of absolutely the same quality, then the useful life—that is, the time taken to fall to 80 per cent. of its original candle-power, will be very different for the two lamps. The lamp with a reduction factor of .8 will probably live from two to three times as long as that with a reduction factor of .9. This circumstance appears to me to make the life test quite valueless.

Now I hold that it is not fair to criticise others' proposals unless one has something which appears better to suggest oneself. As a basis for a life test specification I would suggest the following:—

The lamps selected for life test to be run

for, say, 500 hours, and to be tested for mean spherical candle-power at start, and after 100, 200, 300, 400, and 500 hours. These results to be averaged together. The average candle-power of all lamps tested throughout the 500 hours not to be lower than a certain limit. The average watts and inefficiency should also fall below and above certain limits respectively. Any lamp failing in vacuum during the run to be omitted from the tests. As the final values obtained are the averages of many separate measurements, the personal error in making the measurements is eliminated.

It is open to question whether the lamps should be started on test at their marked voltage or standard inefficiency. The latter is the better plan if the object is to determine the quality of the filament only. This, however, is likely to be misunderstood, and I think that if the lamps are selected so that their average starting inefficiency is standard and the individual variations at start are not great, carrying out the test at marked voltage will be found the more satisfactory, besides being very much more convenient. It must be remembered that, other things being equal, the lamps which start with the highest inefficiency will finish with the lowest, and thus the average will be maintained fairly well.

Now, as regards the determination of mean spherical candle-power: some years ago, this would have meant half a day's work on each lamp; there are, however, several short cuts to this, and I will give four methods.

One way to obtain mean spherical candle-power is to measure the mean horizontal candle-power and multiply by a factor, which, however, must be first determined for the particular make of lamp.

A method that I should prefer is to measure the maximum horizontal candle-power, this involving two measurements, taken on opposite sides of the lamp. This should be multiplied by a factor which is practically independent of the shape of the filament. This factor varies only from .805 to .825 in lamps of all makes.

A third method is to employ an integrating photometer, giving the mean spherical candle-power in a single measurement.

A fourth method is to rotate the lamp on its axis and arrange for tilting it whilst rotating it. This gives the result desired in six measurements.

Inverted Gas-Burner Lighting

By W. Grafton, M.I.G.E.

From The Plumber and Journal of Heating, London.

Incandescent gas lighting by means of the inverted burner and mantle being so very effective and economical, the wonder is that it is not more popular, either for private or street lighting; but like other systems it requires to be understood and handled carefully.

Besides, the very method of directing the gas downwards tends to court failure in obtaining the best illumination, owing to the difficulty of rating these burners to suit all gases. In the factory they are made up to a gauge size, and very often to suit a pressure and quality of gas supplied without any thought of the conditions obtaining in consumers' houses.

Considerable difficulty and trouble is found in adapting the inverted burner to local conditions of gas supply. Each type of burner requires, so to speak, special treatment, not only as regards gas consumption, but the best pressure at which it must be supplied in order to get effective illumination without any hissing noise. It matters not how good the appearance of the burner may be, if there be that disagreeable hissing noise the system of lighting is faulty and present-day requirements are not fulfilled. "Silence is golden" in no better sense than in its application to incandescent gas lighting. The luminous rays are desired without being forced upon one's ear, and it should be the aim of all gas-fitters to see that any installation they have in hand, whether in the home, office, or church, is left a credit alike to himself as well as the gas company.

It matters little how good the lighting is, if accompanied by noise it will be certain to cause complaints in the long run. Avoid it by endeavoring to get any and all burners to consume the gaseous mixture quietly, because, depend upon it, the best burner will not be appreciated if it makes its presence felt in that way. It should be practically noiseless.

Learn to know the effective pressure for the grade of gas the particular type of inverted burner in hand works best at, and do not be satisfied until you get it to the burner silently yet efficiently. All burners can be made to do either separately, but not jointly, and no inverted burner is an acquisition which has not adequate power

or force to produce the combined effect of much light from little gas, and without sound.

With many of this type of burner on the market a very real difficulty is presented, owing to the smallness of the gas aperture or apertures in the nipple, necessitating a pressure higher or lower than prevails in the town's gas supply.

Pressure is the all essential function in the burner, and is governed largely by the size of the gas passage; and upon this hangs the injector effect of the gas currents passing through the burner, as to the quantity of air drawn in to be mixed with the gas. Should the pressure be feeble and a varying one, the gas consumption will also vary accordingly, and the pressure of the inflowing air be upset, so that the gas is liable to flash back, resulting in a luminous flame which soon deposits carbon in the Bunsen tube and mantle.

This is one of the most common troubles experienced with inverted burners, and the whole defect originates in the power of the gas having fallen so low that a sufficient draught is not maintained as will overcome the upward tendency of the air from below, due to the elevated temperature of the burner and its parts.

In other words, we depend upon the potential energy of the gas to impart kinetic energy to the air, which causes it to enter and mix with the gas in the Bunsen tube. Should the pressure and volume of gas, however, be so feeble, and the draught set up not sufficient to draw in air having ample motion, the gaseous mixture, becoming heated and assisted by combustion, commences to exert an upward energy and finally overcomes the initial force of the gas and lights back at the nipple.

It must not be supposed that a mantle suspended or placed on a burner offers no retardation. Slight as a mantle is, it will be sufficient to cause enough back-pressure to prevent the proper proportion of inflowing air primarily mixing with the gas to give a perfectly blue flame, and it is for this cause alone that, when the air is carefully adjusted before fixing the mantle, one often finds vertical as well as inverted mantles coated with carbon.

Nothing is more deterring to the sales or use of these inverted burners, and less likely to invite inspection, than to see several smoked or carbonized up. It is simply a good advertisement *against* their use, and much is made of the fact by electricians. Therefore, see to it that all burners in showrooms or windows are kept scrupulously clean and in the pink of perfection as incandescent lights.

Many users prefer to have a burner with a gas-regulating nipple, so that an increase or decrease in the amount of gas can be secured if desired, independent of the gas-tap on the bracket or other fitting. In adopting the regulating nipple it is necessary for it to be of very fine manufacture and to fit perfectly. The nipple is either fitted with a square or triangular graduated needle working in a round outlet hole, or with a round pin having a center adjusting movement. Some screw horizontally, and are made to shut off one, two, or three of a number of holes in the nipple.

Whatever make of nipple is used, it should be made to work easily and be in such a position that it will not get hot. It is for this reason that many prefer the swan-neck type of inverted burner, with the air-chamber lower down than the ignition point, air and gas regulation being more easily accomplished.

It must be pointed out that any regulation of the gas by the nipple affects the pressure a tenth or two, although stated to the contrary.

Hand in hand with pressure is the grade or quality of gas. This should be kept as practically constant as it is possible to keep it. If coal-gas only, the quality best suited to inverted burners is that known as common coal-gas of, say, 14 or 16 candles, or 550 B.T.U. gross. In the Midlands and the North higher grades of gas prevail, but there is far more trouble therewith, not only in keeping the gas of constant value, but the incandescent burners themselves give more trouble in several ways.

If a mixture of coal and carburetted water gas of like values stated above, so much the better, but then the percentage of the one to the other should be maintained, and if done, the incandescent mantle effects are finer than those obtained by coal-gas only. This is due in the first place to the mixed gases requiring a little more pressure for distribution, although not always applied; and secondly to the lessened quantity of air required to complete combustion of the quantity of gas employed in the burners. The air supply must therefore be under control by the use of an air-slide or adjuster; otherwise it is impossible to prevent "flashing back," which is often no fault of the burner itself, but is due to the kind of gas consumed.

Commercial Engineering of Illumination

Introduction of the Gas Arc Lamp

By Glenn R. Chamberlain.

A paper read before the National Commercial Association.

If one were to write a brief history of gas lighting, it would undoubtedly take a form similar to this:

1. First practical application or use of the discovery of coal gas, by Robert Murdoch, in lighting his own home at Redruth, Cornwall, in 1792.
2. Lighting by gas of the Lyceum Theater, London, England, 1803.
3. First public street lighting by gas, Pall Mall, London, 1807.
4. Discovery of the Bunsen flame at Heidelberg in the early '50's.
5. Discovery of the incandescent mantle by Auer von Welsbach, Heidelberg, 1885.
6. Invention of the gas arc lamp.
7. Practical application of the "inverted" type of incandescent gas lamp, having single or cluster burners, present day.

The two chief essentials of the incandescent system of gas lighting are the Bunsen flame and the mantle, and it may not be out of place to say here a word or two regarding each of these simple but very important discoveries.

It has been said that the Bunsen flame has done more for the prosperity of gas lighting, and the progress of the gas business as a whole, than any other thing. This discovery was made in the early '50's by an assistant to Bunsen, Sir Henry Roscoe, who pointed out to his chief that a non-luminous flame could be produced by passing coal gas a short distance through air and then taking it through a piece of wire gauze. The invention became known to the world as the "Bunsen" flame, and we, of course, owe to it not only incandescent gas lighting, but all of the designs of non-luminous gas fires so commonly used in our domestic and industrial fuel appliances.

By some strange coincidence, the birthplace of the Bunsen burner was that also of the accidental discovery of the mantle, about 40 years later. The story, though old and worn, is always interesting, of how Dr. Welsbach, while pursuing his studies in the rare metals and earths, accidentally allowed a solution containing salts of the rare metals to boil over and evaporate on the fibers at the ragged edge of an asbestos card which was used to support the beaker. The flame was playing around the card and he noticed that the salts became luminous. We are told that he devised a sort of mantle to fit over the Bunsen burner, and it was only after infinite work and patience that his discovery became an assured commercial success.

A close study of the history of the gas industry will reveal that Providence seems, from the first, to have kept a watchful eye over it, and it was indeed a kind Providence, given a generous boost by invention, that saved, to a greater or less extent, the gas lighting business when our one great competitor entered the field. Likewise a kind Providence stepped in at an opportune time and furnished a man capable of successfully clustering these burners into what is called the gas arc lamp. This in its turn has taken up the work of commercial lighting at a point beyond which it was not possible for the single burner lamp to go, and the success of this artistically designed, powerful and efficient unit is in evidence everywhere. Many seem to feel that we are now surely at the end of our resources and that improvements in our illuminating appliances are not further possible, to the extent at least of holding for us permanently the high place we now occupy in the field of artificial lighting. We are constantly hearing of new inven-

tions along electrical lines—in lamps of greater efficiency, designed to reduce the hourly consumption of current per unit and to cheapen costs to the consumer. Happily, however, invention is not the monopoly of any particular industry, and it is at work also for us, producing results which make us very optimistic as to the future. For example, we have every reason to believe that the entire success of the inverted gas arc, as well as the single burner lamp, is assured.

To the gas man looking for detailed information regarding the gas arc, and for arguments and methods for pushing its sale, much that is helpful and practicable may be readily found in the booklets and other advertising literature furnished gratis by the manufacturers of these lamps. The city which the writer represents is credited with having in use, considering its size, a large number of gas arc lamps, both of the inside and outside pattern, and it would be difficult to trace the cause to any other than a well trained force of representatives or solicitors who are constantly hammering, hammering, hammering on their commercial lighting prospects. Coupled with this, of course, is required sufficient pressure to well fill the mantles of the lamp, and a well organized maintenance department, whose instructions are to give the service that will keep every lamp in the business district shining like a new, gold dollar. These conditions, backed up by a desire on the part of the company to give the gas consuming public the "best there is in the basket," ought to win for any company a large share of the commercial lighting without being obliged to give away either the lamps or the gas. This is business that will not force itself upon a company to any noticeable degree, but must be gone after, and vigorously.

Good maintenance service cannot be over-estimated, and, in fact, a representative should be given but little credit, indeed, for the sale of a gas arc, whether displacing electricity or not, unless the order is accompanied by an agreement for maintenance service. Arc lamp users will not properly maintain their own lamps, and maintenance service furnished at cost, or even at a slight loss, if well done, is vastly more remunerative to a gas company than other advertising methods, which at best in this line are more or less of a haphazard nature. For the year 1906, just closed, there were maintained without loss to the department about 5,000 gas arc lamps per month. The uniform price charged was 20 cents per lamp per month, and the service included all cleaning, renewals of mantles, glassware, etc., making 4 calls on each lamp per month, and, figuring all expenses incident to this work, such as blank forms, records, clerical salaries, etc.

Many gas companies seem to have educated themselves to the belief that because their competitor makes free installations of the electric arc they must do it also in order to get and hold business. In the light of the experience of many other companies, operating under conditions otherwise similar, this would not seem necessary—at least not necessary if never begun. It must be borne in mind that there are but very few instances where the electric company can deliver as much light, say for 2 cents, as the gas arc will furnish, and the consumer can, therefore, well afford to pay a fair price for the lamp and still save a good round sum by so doing. Does it not seem inconsistent to equip one store with chandeliers and single burner lamps at a fair profit on the sale, and equip the store next door with gas arcs free, or at less than cost? It would seem that disadvantages accrue to the company which follows the practice of making free installations of gas arcs, or, in fact, any other gas consuming appliances, among which may be mentioned:

1. An enormous investment in appliances which rapidly deteriorate in value, principally because of improvements constantly being made in the construction of such appliances.

The superintendent of a very large gas company recently remarked that his company did not attempt to keep up with the times in this particular—was, in fact, still buying an earlier design of lamp, and dared not show or light up his office with the latest pattern, because as soon as his old consumers saw them there would be a clamor for a change, and his company could neither afford to comply with such requests nor to offend the good old consumer by refusing.

2. When we give away appliances or sell them below cost, it would seem to be an admission that, although we may be successful gas men, we are not successful merchants, and it must also naturally appear to the public that the gas sold through these appliances must net the company so great a profit that the gratuitous distribution of many thousand dollars' worth of appliances is to us a mere bagatelle—an erroneous impression for which we have only ourselves to blame.

3. An amount of money, not greatly more than liberal interest on such an "investment," could be expended on good solicitors, who would sell at a profit practically as many lamps as are now installed free or at less than cost—*i. e.,* compared with the free installations that prove to be profitable gas consumers.

4. Because any proposition of a free nature attracts a large proportion of unprofitable business and, unless closely guarded, lamps will be installed that will show no consumption for months, simply because they are being used as a convenience—an "ever ready"—in case of a temporary suspension of the electric service.

It is, of course, not always easy to convince the consumer that we, as merchants, cannot afford to sell our appliances at a loss, and the experience of our company with a certain clothing man might be of interest in this connection. This man is a type of merchant who might be called a "clever" buyer, were it not for the fact that it is sometimes necessary to buy more than once at the same place. He persuaded us to put in a half-dozen new lamps, with the understanding that if they proved economical in consumption and otherwise satisfactory, he would at the end of thirty days pay our net cash price. He stood us off for three months before coming to a satisfactory decision with himself, and then offered us half price, using the argument that inasmuch as the lamps were now second-hand, and if taken back by us could be sold only at a reduced price, he therefore should be given the first opportunity of buying them as second-hand arcs. This experience reminds one of the story of the old pawnbroker who was contemplating the purchase of a watch, which a friend had allowed him to keep over night to examine. His soliloquy on the subject ran as follows: "He wants $10 for it, but he will take $8; I think it is worth $6, so I'll offer him $4."

The problem of outside gas arc lighting is now receiving considerable attention, and abundant experience has already been had to prove that this method of lighting is not only economical and practicable for the merchant, but is a good source of revenue to the gas company and a most excellent advertising medium for both. Our company started its campaign for outside gas arc lighting by encircling the triangular block in which our office is located with a band of 1½ pipe from which arc lamps were suspended at certain intervals. Two risers, with meters connected, supply gas to these, the meters being there for a check on the actual consumption. These lamps for two years have been successfully lighting, not only the street and sidewalk, but in many cases the show windows as well, and are paid for by the merchants in the block on a flat rate per lamp basis, the lighting hours being from dusk to 11 o'clock, the lighting and extinguishing, of course, being done by the company's men. This was quite extensively advertised as the "Triangle of Light," and much outside lighting business has since come in readily. The plan has, therefore, been seriously considered of going to block-after-block of this flat rate outside lighting on those main business streets, where a continuous band of lights can be assured.

Undoubtedly many gas companies have been hindered more or less in their efforts to secure business by unfair statements made by, or in the interests of, competitors regarding certain alleged bad effects produced by the burning of gas in an inclosed room, and the following article, quoted from a competent English authority, may, in extreme cases where a defense is needed, prove of some value: "Many people, though recognizing the greater cheapness of gas, tell us that they prefer the electric light because they consider it cleaner and more healthful. One frequently hears it said that the sulphur products and carbonic acid from gas are liable to damage the pictures, bindings of books, etc. On such a point Prof. Percy F. Frankland, of the Birmingham University, will probably be accepted as a competent witness. In the year 1902 that distinguished scientist was requested to report on the lighting of the large room of the Birmingham Art Gallery, and, as a result of close observation and carefully conducted experiments, he found that with adequate ventilation—and, of course, ventilation is necessary whatever method of lighting is employed—the room was freer from carbonic acid when incandescent gas lamps were used than when electricity was the illuminant. This, indeed, is understating the matter, for what he found was that, when electric arc lamps were employed, there was a marked increase in the carbonic acid in the room, while, on the other hand, when gas was being burned, instead of there being any increase there was a distinct diminution in the percentage of carbonic acid. The reason for this is that the live flame of the gas, by keeping the air in motion, promotes ventilation, and thus helps to keep the atmosphere pure.

"Still more striking is a paper read by Dr. S. Rideal before the Sanitary Institute, Glasgow, July, 1904, in which it was stated that, as a result of experiments made in London by himself and Dr. Otto Hehner, it had been found—and had been so reported to the Board of Trade—that there was more sulphuric acid, proportionately, in the outer air than in the air of a closed room in which gas had been burning for some time. Let it be noted, too, that the room in which the tests were made was one in which all the usual openings were closed, and there were no means of ventilation except through the walls. The important factor, Dr. Rideal explained, was the absorbent action of the ceiling and walls of the room, the sulphur acid being at once fixed by the lime.

"An important question is, of course, that of the effect of different lights on the eyesight. There is a consensus of opinion that the ultra-violet rays in the electric light are injurious to the eyes; and I notice, in a paper read before the Public Health Congress, July, 1905, the opinion is expressed that the worst form of artificial lighting for schools is the electric light, unless the 'red rays' are killed. On that point the well-known medical journal, the *Lancet*, said not long ago: 'For some not very clear reason, the light of the incandescent electric lamp seems to be wearing, or taxing the muscles of accommodation of the eye, and a great many people complain that reading by the electric lamp gives rise to headache. Possibly the fact that the light is rich in red rays, especially when the lamp is not burning with full efficiency, may have something to do with it, or perhaps the distribution of the light from a loop instead of a fixed center may have some disturbing effect on the eye.'

"In view of such testimony, one cannot wonder that gas is finding increasing favor for school lighting, and that at Brierley Hall, in South Staffordshire, for example, it was decided quite recently to remove an electric installation and substitute gas for the lighting of the Free Library and Technical School."

While we, as gas men and gas appliance manufacturers, have every reason to congratulate ourselves on the excellent showing we have made and are making, it behooves us to "keep our fingers crossed," as it were, and also keep in mind the saying that "It is in general more profitable to reckon up and correct our defects, than to boast of our attainments."

United States Government Standardizing Specifications for Incandescent Lamps

At a meeting of the Association of United States Government Electrical Engineers and the representatives of the leading incandescent electric lamp manufacturers throughout the country, held in Washington, D. C., on February 25, 26 and 27, standard specifications covering incandescent lamps used by the various Departments and Bureaus of the Government service were discussed and mutually agreed upon.

The Association of Government Electrical Engineers, which is an entirely unofficial body, was formed for the purpose of drawing up specifications and making recommendations to the various Departments of the Federal Government, and consists of the following officers and members:

Dr. N. Monroe Hopkins, electrical engineer, Navy Department, chairman; Mr. J. E. Woodwell, electrical engineer, Treasury Department, vice-chairman; Mr. W. C. Allen, electrical engineer, District of Columbia, secretary.

Committee on Standardization of Incandescent Lamps.—Dr. E. P. Hyde, Bureau of Standards; Mr. B. F. Fisher, electrical engineer, Quartermaster's Office, War Department; Mr. J. E. Woodwell, electrical engineer, Treasury Department; Mr. W. Y. Avery, Bureau of Equipment, Navy Department; Mr. P. L. Dougherty, electrical engineer, Treasury Department; Mr. W. C. Allen, electrical engineer, District of Columbia.

In addition to the above, the association comprises the following members: Mr. C. Gleim, United States Capitol; Mr. C. L. Harding, Library of Congress; Mr. H. L. Hibbard, electrical engineer, Bureau of Construction and Repair, Navy Department; Mr. F. T. Powers, electrical engineer, Government Printing Office; Mr. A. S. Riddell, electrical engineer, Post Office Department; Mr. R. H. Chappell, Bureau of Engraving and Printing; Mr. W. B. Hadley, Washington Barracks, War Department; Mr. Joseph S. Hill, electrical engineer, Interior Department; Mr. F. E. Cady, Bureau of Standards; Mr. E. E. Gillem, Office Public Buildings and Grounds; Mr. P. J. Cribben, Government Printing Office; Mr. Charles R. Sugg, Government Printing Office; Mr. Thomas H. Humphries, Quartermaster's Office, War Department; Mr. George E. Lamb, electrical engineer, War Department.

Miscellaneous News

BRINKLEY, KAN.—The citizens of Brinkley are in favor of the municipal ownership of the electric light and water plants in that city. The City Council is hopeful of securing the passage of an act by the legislature permitting the city to issue bonds to make the purchase. An offer of $15,000 will be made the companies operaing the present systems.

CHAPMAN, KAN. — The Dickinson County Light and Power Company are installing electric lights here. The power house is now being built one mile north of the city. The lights will be in order in about 60 days. The actual cost will be about $5,000.

CINCINNATI, OHIO.—A receivership for the People's Gas and Electric Light Company, of Xenia, Ohio, a corporation capitalized at $175,000 and controlled by the Western Gas and Electric Light Investment Company, a South Dakota corporation, with offices in Chicago, was asked in the United States Circuit Court here by Evelyn Bard, of Chicago, a holder of bonds of the Xenia company.

It is charged that the company has been mismanaged, and that through failure to pay taxes there is danger of the plant being sold for taxes and of losing franchise rights.

COFFEYVILLE, KAN. — The light commissioner recommended that the Council charge a rate of 4 cents per kilowatt for all parties using from one to 100 kilowatts and 3 cents per kilowatt for those using over that amount, or if the city owns the meter a 2-cent additional charge is to be made. A power rate for daylight load only on motors of over one horse power to be as follows: One kw. to 1,000 kw., two cents per kw. One thousand kw. and over, 1½ cents per kw., with a minimum rate of $1 per month up to ten horse power and 75 cents per month of ten horse power and over.

The Council decided to try this rate during the month of March. The meters will then be read and if it is found that their January and February bills exceed the amount of the March bill under the new rate credit will be given for the overcharge in January and February.

It was then decided that everyone whose light bill on the flat rate be over $2 per month be required to put in a meter within 30 days or the light be cut off.

FREEPORT, L. I.—Village President Hiram R. Smith, who is retiring from office, has issued to the Board of Trustees a letter, copies of which have been distributed to residents, concerning the municipal electric lighting system, to remove any wrong impressions that may have been created by what he terms "reckless and misleading statements" made in reference to the plant.

President Smith shows that during the past year the incandescent system gave the village $11,987.08 in receipts, a gain of about $1,200 over the previous year. After paying operating expenses the system afforded the village a profit of $5,373.48. Of this sum, $3,132.21 was spent for extensions, enlarging the business of the plant that much. After the expenditure for extensions $2,247.27 was left. This would have been ample to have paid the incandescent system's share of the bonded indebtedness and interest had it not been necessary to use $1,000 for paying for the street lights and $500 to pay added expense in the general fund necessitated by extraordinary legal expenses. President Smith congratulates the citizens of Freeport upon owning their plant and not giving away a franchise which will in future years be a very valuable one to the village.

In the street lighting department actual operating expenses were $4,634.57 for running over 100 arc lights on a moonlight schedule. There should be added about

$1,000 for depreciation and about $400 for the street lighting department's share of interest on bonds, making the total expense about $6,000.

From a comparison of charges made by various lighting companies in different parts of the State, President Smith states that it would seem that the average charge for arc lights on a moonlight schedule is $70 a light. If the Freeport plant was operated on an all-night schedule he estimates the cost would be about $7,500 for the 100 or more lights. President Smith states that it was claimed the street lighting system was operated some years ago for $2,500 or thereabouts. He says this was not done nor could it be.

HADDONFIELD, N. J.—J. H. Young, Perry Bldg., Philadelphia, Pa., has been engaged to prepare plans for municipal electric light and water-works systems. Estimated cost, $125,000.

NEW YORK. — Alexander C. Humphreys, president of Stevens Institute, began with Alfred E. Forestall, a leading engineer of this city, and Robert M. Searle, an authority on lighting from Rochester, an investigation into conditions of gas supply outside of New York City in this State. For 45 years the best engineering brains of England have been bent upon the problem of fixing some standard of candle-power in gas for general purposes. In a few weeks Dr. Humphreys and his committee, appointed by the Empire State Gas and Electric Association, have undertaken to prepare for submission to the State Lighting Commission data upon which to base the order which the commission has declared it will issue for a fixed gas standard. The commission has intimated its willingness to use the results obtained.

The investigation of this body of experts and the action of the State in fixing an illuminating standard will make history in the world of science as well as of practical illuminating engineers. London has after a generation of laborious research undertaken to fix a standard of 13 candle-power for illuminating gas. With this exception and that of Massachusetts, where a standare of 15 candle-power was fixed some years ago, New York State will be the first authority in the world to prescribe a definite mark to which gas must be kept up.

Several features of general popular interest have developed in hearings before the State commissioners and the committee of experts. The passing of the old open-flame gas burner is indicated by reports from all over the State laid before the committee. More than 80 per cent. of all the gas manufactured to-day, it is stated, without contradiction, is used for fuel, power or in the more modern incandescent burners. Practical gas men predict that within five years the old-fashioned flat-flame jet under which they studied their A, B, C's will become as obsolete as the tallow-dip is to-day.

NORWICH, CONN. — The Norwich Electric Company, of Norwich, has filed a certificate of incorporation with a capital stock of $5,000. Charles J. Twist, James M. Fillmore, and Carroll L. Adams are the incorporators.

OMAHA, NEB.—A clean-cut issue between municipal and private ownership of city lighting has been raised here by a report made by Professors C. R. Richards and G. H. Morse on the Lincoln municipal lighting plant. Considered from all directions, and including all amounts which two trained, disinterested statisticians say should be charged, Lincoln street lighting costs the city $98.84 for each arc light.

In Omaha, where a private lighting company has the contract, a rate of $75 an arc light is made, and from this $75 rate there are certain reductions because of taxes and royalty which bring the cost of the Omaha lights to only about half that of the Lincoln municipal lights.

Lincoln and Omaha are only fifty miles apart. They have practically the same freight rate on coal, wages are practically the same and other business conditions are so similar as to be practically the same. The issue raised, therefore, can be compared between Omaha and Lincoln probably better than between any other two cities in the country.

VALE, ORE.—Electrical engineers arrived in Vale and are surveying for the electric light system for Vale. They say the system will be completed in 60 days. The city has granted the company a 20-year franchise for both water and lights. The company will take up the water system as soon as the electric light plant is well under way.

VICTOR, N. Y.—The village of Victor is much agitated over the question of municipal lighting. It is a case of electricity vs. acetylene. The annual charter election of Victor village occurs on Tuesday, March 19th, and one of the questions to

be submitted is, "Shall Victor appropriate $7,500 for an acetylene gas lighting plant for village lighting?"

A matter of such importance naturally causes a difference of opinion and the advocates of each system have been canvassing the village and exploiting their preferences in many ways. Perhaps the most dispassionate and equable discussion of the matter is contained in an interview given by Walter T. Goddard, the electrical engineer of the Locke Insulator Company.

Mr. Goddard represents the main industrial concern of Victor only as an expert in lighting, for while the firm would be able by enlarging its present lighting plant to provide light for the village it has not sought to do so, nor solicited the opportunity. In fact if the village decides to reject acetylene and vote later for electricity it is highly probable that the power will be furnished by the Rochester and Eastern Rapid Railway Company.

In part Mr. Goddard says:

"Of first importance in any lighting system for use in the home, is the question of safety, and in this regard acetylene gas is notorious. In the first place it is highly poisonous even in small quantities, and, secondly, it forms with air, one of the most explosive combinations known. It may be argued that ordinary illuminating gas has this same characteristic, but there is this difference: illuminating gas is very particular about the proportion required to form an explosive mixture with air, while acetylene gas, if mixed with almost any proportion of air, will explode with extraordinary vehemence.

"In this matter of danger from explosion it may be of interest to know that Will Woodworth, who is now at Los Angeles, reports that an acetylene plant near there recently exploded, injuring thirty people, nine fatally. Certainly a strong argument in favor of a less dangerous agent. Careful construction of gas machines has rendered acetylene comparatively safe, but though house mains and machines be ever so carefully constructed, the facts of the gases' explosiveness and poisonousness still remain, forces of incalculable strength."

WICHITA, KAN.—The United Gas Company, which purchased the Wichita Gas, Electric Light and Power Company, announced that new machinery will be purchased to be installed in the electric light plant at a cost of $75,000 to $100,000. This will be done in order to give the patrons of the electric light company adequate service, which has been impossible heretofore.

A petition will be presented at a meeting of the City Council for a franchise to the new company, giving an extension of the old franchise and allowing for a vast improvement in the service.

The new owners, who are Wichita business men, are well aware of the fact that the electric light service has not been acceptable, and have already started in to give the city what it desires and needs. This new franchise will be along the lines of a larger and better plant—one commensurate with the size of Wichita.

One of the stockholders stated that the machinery now in the old electric plant was almost entirely worn out, and unfit for use—a fact which needs no proving to those who have used the lights and had them go out several times in a night.

Taking this into consideration, the new company has already taken steps to put in entirely new machinery, which will be done at a cost of from $75,000 to $100,000.

It is not expected that any new buildings will be erected, as the present one will be sufficient, but entirely new machinery will be brought to the city this spring and a plant put in operation which will give all the light necessary.

Aside from a better grade of electricity the new company will also enlarge the scope of service and be able to take care of more streets and houses than before.

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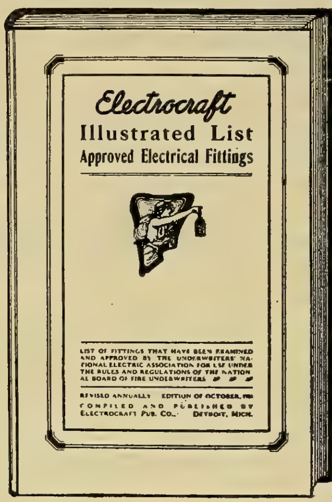

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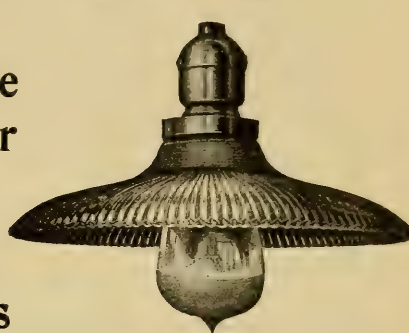

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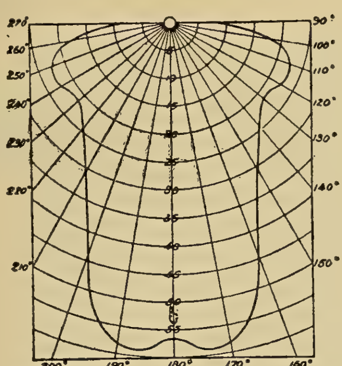

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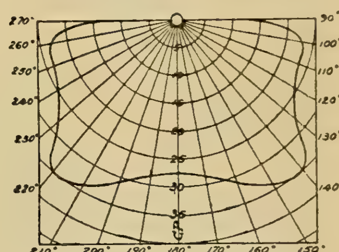

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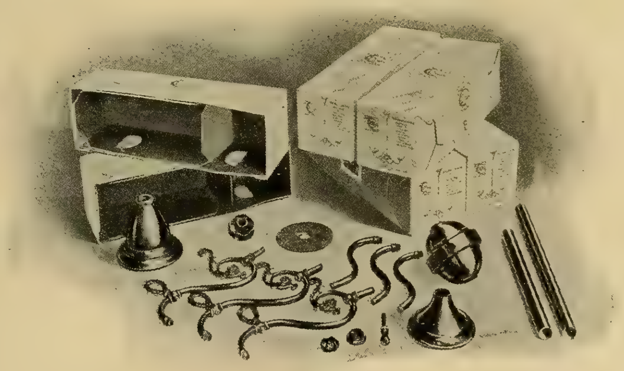

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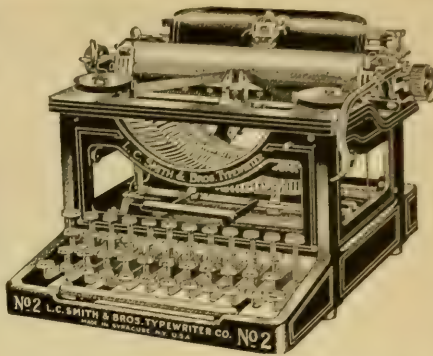

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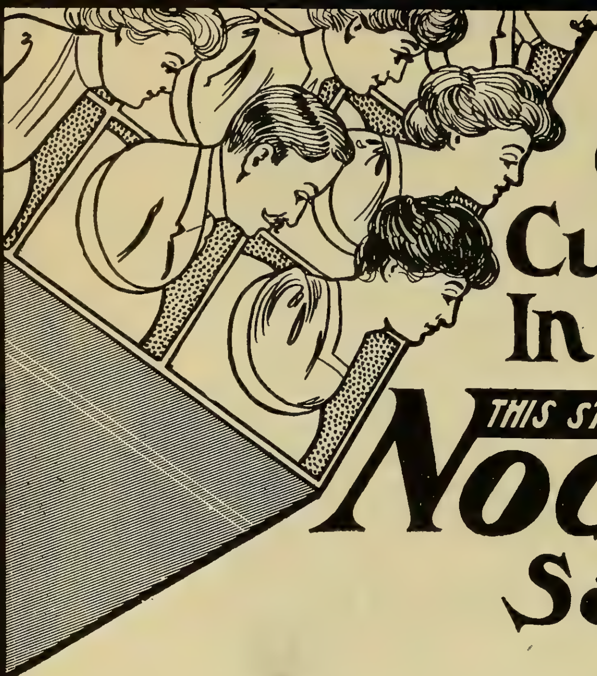

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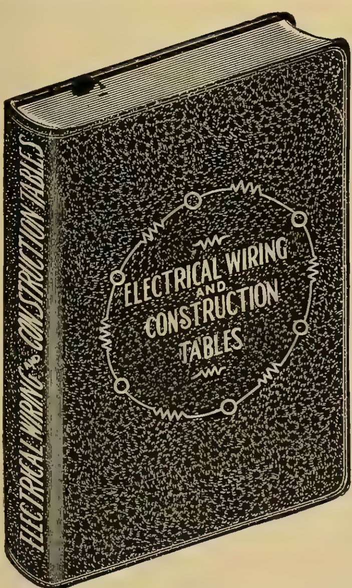

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Entered as Second Class Matter, January 13, 1907, at the post office at New York, N. Y.

LEON GASTER.

Mr. Gaster has been waging an aggressive campaign in the interests of illuminating engineering in England. He is now on a visit to this country, having come as a delegate from the Faraday Society to attend the formal opening of the Engineering Societies' Building.

THE ILLVMINATING ENGINEER

Vol. II. APRIL, 1907 No. 2.

Where Light is Most Needed in the Household

By "Multipolaris."

A great philosopher of the evolutionary stripe has shown conclusively that the habit of wearing clothes arose originally from a desire to decorate the body rather than to protect it. Whether or not the use of artificial light had a similar origin it would perhaps be hard to say; but the frequency with which lighting devices which are supposedly of a decorative character,—but many of which are of the æsthetic order of nose-rings and tattoo marks,—are found in the parlor or drawing room, while inefficient and dilapidated fixtures disgrace the kitchen and other parts of the house in which the actual work is done, goes far toward bearing out such an assumption.

If something of the same effort were made in the household for securing conveniences and improvements for doing the various work connected with it as is done in manufacturing establishments, the so-called "servant problem" would undoubtedly be much less serious than it is at present. Not the least among the handicaps under which a great deal of household work is done is that of poor lighting. The waste occasioned by misapplied ideas of decorative effects in the more conspicuous, but less used parts of the house, is often made up by curtailing the light in those places where, generally speaking, the illumination should be the best. Take for example the kitchen; in a great number of cases a single 16-candle-power electric lamp, or an old-fashioned flame gas tip, supplies the entire illumination. Often a two-light "combination" fixture, of the simplest and ugliest form is installed; "you pays your money and you takes your choice"—of gas or electric light. Naturally such a fixture is located in the center of the room; and as the cooking range, work tables, etc., are always located around the sides of the room, it is impossible to work at any of these without being directly in one's own light. The electric lamp is generally blackened on the inside from the overworked filament, and on the outside by the combined agencies of smoke, dust, and

flies, the result of the whole combination being that its light is cut down one-half. A lamp chimney is supposed to be washed occasionally; but an electric lamp is a mysterious and awe-inspiring affair to the average maid, and is left *solus in gloria*. As a matter of fact, it is as easy to remove from its position as most lamp chimneys, and far easier to clean, but it is doubtful if one out of a thousand lamps used in such a position receives so much as the touch of a dust cloth from the time it is installed to the day that it breaks.

If gas is used instead of electricity —and in many cases where both are available the gas flame is left for use in the kitchen while the electric light is reserved for the parlor—an ordinary fish-tail burner, with the cheapest kind of pressed glass shade, is the equipment provided. Often a flaring tongue of flame will take a chunk out of the side of the shade, which, while giving a rather bizarre effect, generally adds to the useful illumination by allowing that much more light shine down where it is required. If the fixture is already in place, it is of course, somewhat troublesome to remedy the first and chief defect, that is the light being located in the center of the room. The sensible arrangement is to put up at least two side brackets, so arranged that they will light up directly the work tables and range, where light is most required. Eight candle-power lamps, fitted with suitable reflectors, and kept decently clean would give an elegant working light; and if extreme economy is necessary, even one of the lamps will be sufficient a considerable portion of the time. To make the best of the single lamp, however, it should be provided with a nearly flat reflector and the same care taken in order to keep both lamp and reflector clean that would be given to a lamp chimney.

"IT IS IMPOSSIBLE TO WORK WITHOUT BEING DIRECTLY IN ONE'S OWN LIGHT."

For the old flickering, hissing gas flame there is absolutely no justification. Modern incandescent gas burners, complete with chimney, mantle, and a

"THE SENSIBLE ARRANGEMENT IS TO PUT UP SIDE BRACKETS."

reflector, can be bought for 40 cents up to two dollars. They burn less gas than the ordinary flame, and give a flood of steady light which will brilliantly illuminate any kitchen of ordinary size. The chimneys of these burners accumulate dust in the same way as a lamp chimney, and should, therefore, be frequently cleaned. Many are so afraid of breaking the mantle by removing a chimney that the chimney is left on without cleaning until the mantle breaks from natural causes. With ordinary precaution, however, it is a perfectly easy matter to remove and replace a chimney any number of times without danger to the mantle. A broken mantle should be at once discarded, and also one which has become shrunken and therefore gives little light. The kitchen walls and ceiling should be either white or light cream color, which will nearly double the general illumination.

A dark hallway is an abomination which is altogether too common. The necessary amount of light to enable one to pass to and fro with facility is very small, and to omit it altogether is not economy, but downright parsimony. There are doubtless a large number of housekeepers who do not even know that there are smaller size lamps than the 16 candle-power with which they are most familiar; and the

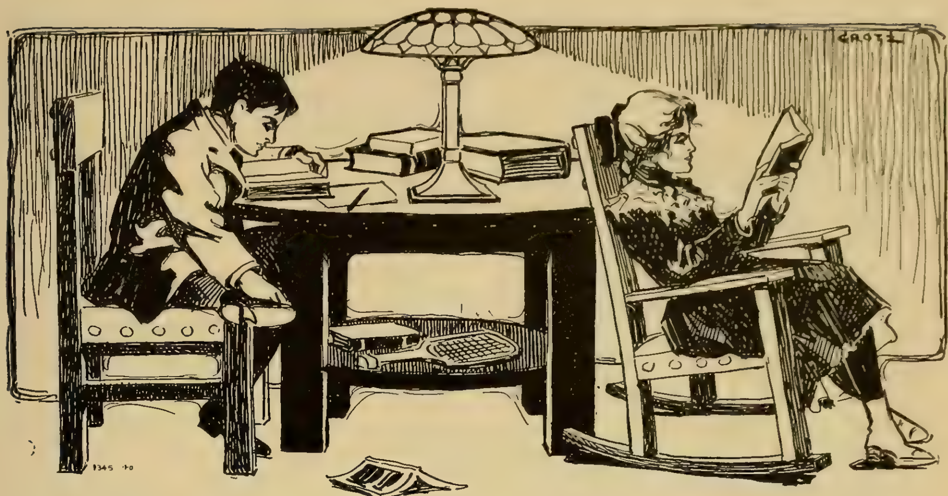
"A 'COMBINATION' FIXTURE OF THE SIMPLEST AND UGLIEST FORM."

"A DARK HALLWAY IS AN ABOMINATION."

lighting companies cannot be accused of making any strenuous efforts to disabuse them of this notion. In many cases a four candle-power lamp would be every bit as good as the sixteen; but here again the user is liable to the advantage which he expects to gain, by getting a lamp that gives but 4 candle-power while taking the current of an 8 candle-power lamp. A good "sign lamp" of reliable make will generally be honestly rated in this respect. In some cases where lamps are furnished by the lighting companies, only 16 candle-power lamps are supplied; but it would be far cheaper for the user to pay for a 4 candle-power lamp to use in places where such a lamp would give sufficient light, than to have the ordinary size lamp given to him. At the average cost of current for household purposes, a lamp of the ordinary size, 16 candle-power, will use up $4.00 to $5.00 worth of current, while a 4 candle-power lamp of good quality will use up somewhat less than half this amount, that is, from $2.00 to $2.50 worth. The lamp itself costs 20 cents: the saving is, therefore, apparent.

If gas is used, a one foot tip of good quality will answer the purpose; it is much better where only a small amount of light is required to use a small burner at its full capacity than to turn down a large burner. At the ordinary cost of current a 4 candle-power lamp will cost about ¼ cent an hour, and a one-foot gas burner 1/10 cent an hour. Is there any other convenience in the household which can be obtained so cheaply? The price of a glass of soda water (or a beer) will keep a one-foot gas flame—sufficient to light an ordinary hallway—burning all night for a week; and the price of an ice cream soda (or a Wurtzberger) would supply a small electric lamp for the same time. Of course, there is no objection to having both, or all three—if you have the price; there is very little excuse for not having at least the light.

If there is a nursery or study room for children or young people, its lighting should receive the most careful attention of any room in the house. The theory that anything is good enough for children is diametrically wrong on general principles, and in the case of lighting, may be a very cruel mistake. Unshaded electric lamps, or incandescent gas lamps, should no more be tolerated in such a room than would loaded firearms. Frosted lamp bulbs, or better still, frosted or green shades, should be used in all cases. If reading is to be done, either an electric lamp or an incandescent gas lamp fitted with a green and white shade, or some equally good device, so placed that no part of



BAD POSITION: LIGHT SHINING IN THE EYES, DIRECT REFLECTION FROM BOOK, CHEST CONTRACTED.

GOOD POSITION: EYES SHADED, NO REFLECTION FROM THE PAPER, CHEST EXPANDED.

the mantle or filament can possibly be seen, should be provided. The habit of sitting with a book or paper on the table should be discouraged as far as possible. In such a position the light shines on the paper in such a manner as to reflect directly into the eyes, and furthermore gives a stooping posture to the body, which is in every way bad. For reading, chairs should be placed with their backs nearly squarely to the table, and the reader sit leaning backward, and with the light falling over the shoulder. For writing, the paper should be so placed that light will come from the left and slightly in front. A reading lamp placed on the table is generally far better than any arrangement of light from a chandelier. If lamps in such positions are used at all, they should be thoroughly shaded with frosted or other diffusing globes. The tests that have been made in New York and other large cities of the eyes of school children show that there is an appalling extent of defective vision. Lack of care and attention in this respect is inexcusable; while, to permit or supply a light that is a strain upon the eyes of children for the sake of saving a few cents a month, is an outrage worthy of the most serious condemnation.

The cellar is a place which has to be visited more or less often at night. The practice of lighting one's way by striking matches is both inconvenient and dangerous, as is also that of carrying a lighted candle, and a kerosene lamp is not much better. Where neither gas nor electricity is available of course such inconveniences must be put up with. If only gas is at hand, a jet should be placed at the entrance where it can be at once found and lighted, so as to illuminate the stairs, and as much farther into the cellar as possible. Other jets may then be placed where the most light is likely to be wanted, such as near the furnace and laundry tubs. The same directions apply in the case of electric lamps; but in this case, a switch should be placed at the entrance.

No part of the house interests the feminine contingent more than the closets. Ample and well-arranged closet room will atone for many sins of construction of the other rooms. Where electricity is available every

closet should be provided with an electric lamp, an 8 candle-power being plenty large enough. A light in the closet is like a revolver—it may not be wanted so often, but when it is wanted it is wanted badly. Fumbling around in a dark closet is an entirely unnecessary strain upon one's patience.

The lighting of the servants' private rooms is worthy of decent attention. To put them off with a flickering gas light, or an electric lamp badly placed and badly shaded, is to deny them a comfort which they have a right to demand. This is particularly true in view of the fact that good and proper illumination can be provided usually at less expense than the trying and unsatisfactory light generally found. The economy of the incandescent gas light has been mentioned, and good illumination from an electric lamp is only a matter of the right placing, and the selection of a suitable shade. The cheerfulness of a room at night, which is nearly the only time that the house maid is in her room, depends more upon the light than any other single thing, and care and thoughtfulness in this regard will in the long run be amply repaid by the greater contentment and better service secured.

What has been said thus far applies only to the city house, where a supply of gas, or electricity, or both, is to be had from public service companies. All the convenience of gas light obtainable from the regular "city gas," with an illumination of the most beautiful quality obtainable from any light-source in present use, may be had at small trouble and expense in the village or country house by the use of acetylene. A kerosene lamp is capable of giving very excellent illumination, when properly cared for; but keeping lamps in proper condition requires a "continuous performance," which soon becomes a most irksome grind and is therefore generally neglected. An acetylene generating plant is an apparatus which requires no greater skill in its use than an ordinary heating furnace, and takes up about the same amount of room, but requires much less attention; once a month, or such a matter, is as often as it needs looking after. There is an old notion that acetylene is dangerously explosive. As applied to the present day generating plant this is an entirely mistaken idea, as there is no more danger from this gas, if as much, as from ordinary illuminating gas.

In general it may be said of lighting as of most other household utilities: economy and satisfactory quality are by no means antagonistic, but go hand in hand as the result of intelligent and thoughtful management.

FIVE CENTS' WORTH.

Styles in Electric Signs

By Richard E. Brown.

That the value of the electric sign to a merchant lies in the impression it makes on the public mind, and its resultant effect as an advertising medium, is being more clearly realized by central station men every day, and it is eqally true that the general public is rapidly waking up to this fact. The result of this knowledge is being shown in the handling of the sign business by many central stations in a more intelligent manner than has heretofore been the case, and by the embodiment of various "styles" uncontemplated in their output until a comparatively recent date. Up to the present moment a majority of the central station managers, where the free sign policy has been adopted, have provided only one or two general styles of signs without cost to their customer. First, the individual letter sign containing 14, 18, 24 or 30-inch letters, studded with electric lights of either 2, 4 or 8 candle power (see Fig. 1); and second, any one of the standard forms of the various panel signs of either the oval, round, square, oblong or octagon shapes (see Fig. 2), with the panels enameled and lettered as the customer directs, and with the outer frame studded with either 24, 28 or 32 incandescent lamps of 4 or 8 candle power.

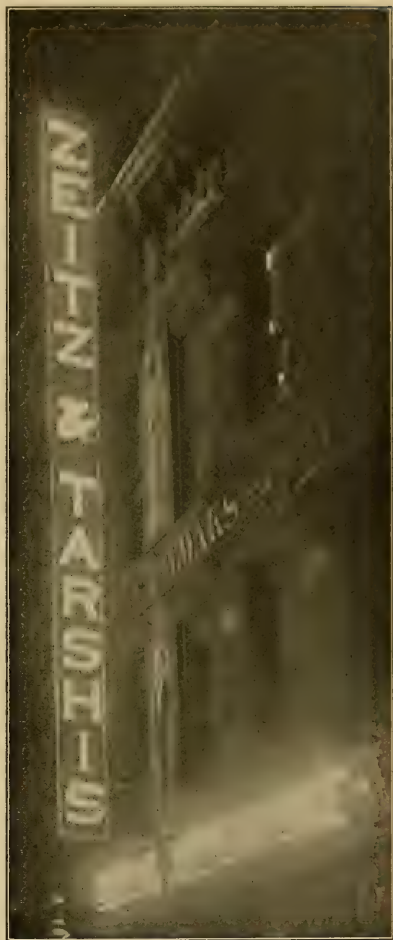


FIG. 1.

The idea of providing free signs for the customer has been generally restricted to these types, and in a majority of cases where a sign of special design was requested, fully 80 per cent. of the central stations have required the customers themselves to purchase and wire for such signs, and naturally the result has been that a great deal of prospective business is lost.

If one takes into consideration the advertising value of the sign to the station, as well as to the customer, in addition to the revenue derived from the current consumed on a sign, it would appear to be somewhat of a short-sighted policy to turn down business of this special character, more particularly as special design signs, as a rule, cost approximately the same as standard designs, produce at least the same revenue, and give the consumer exactly what he wants, thus fulfilling the requirements of the primary idea


61
WILLIAMSON'S
EXPRESS
CO
McDOUGALL & LAWRIE
SHOES
EHLER'S
UNIVERSAL
BOWLING
ACADEMY
H. J. BRIDGER
DIAMONDS-JEWELRY
ELEPHANT
CLUB
ANTI-TRUST
BOITEL
CIGARS

FIG. 2.

in the installation of the electric sign, viz., that of acting as a distinct advertising medium and producing an impression on the public mind favorable to the merchant using it. This seems to be a matter which many station managers have heretofore either ignored and overlooked, but which they can no longer pass by. Business competition grows keener each day, and this the average merchant and I really cannot see what benefit I will derive if I have a sign over my door which is exactly the same as the one the man next door has." To offset this argument successfully is the secret of the necessity for the embodiment of various styles in signs, and the manifest advantage of this to the central station in a progressive sign campaign cannot but be apparent. Granted to be sure that in opening a campaign on

FIG. 3.

business man fully realizes, and when the solicitor approaches him with the sign proposition in nine cases out of ten he is told, "Your proposition is a good advertising proposition, but it is not exactly what I want. Now, if you will show me a sign that will be a little different from those used by my competitors, something that will be a little distinctive, I shall be glad to discuss the matter with you, but, as it is, undeveloped territory that for one and possibly two years after the canvass is started the standard sign will suffice. But after that period, as sure as fate, up bobs the question of "style." There can be but one course which will then bring in the business wanted. Take up the question of style; have designs drawn up to meet the demands of the prospective customer; give him the special sign that he wants, and every

customer will become a satisfied customer, who will advertise your output, and who will be an enthusiastic exponent of the use of the electric sign as well. Give John Jones a sign such as he wants, and when he drops in next door to see Jack Robinson and they commence to talk over business and their various advertising mediums, he will naturally say to Jack Robinson, "Before you do anything on advertising, why don't you see the Electric Light Company and get an electric sign; they will give you a better sign than you can buy yourself and they won't charge you anything except the cost of the current used on it, and its a great business getter." The logical effect of a talk of this kind is a call on the central station for information regarding the electric sign proposition, with the usual result that in 90 per cent, of the inquiries from prospective customers another sign is contracted for and added to the system.

One of the largest central stations in this country, having had standard signs on their lines for several years, has recently worked out a sign campaign somewhat on this basis, abandoning its old policy of supplying nothing but standard style signs to the customer. The effect has been that within six months from the commencement of the experiment they have nearly doubled the number of signs on their system. Think of it! An increase of nearly 100 per cent. in only six months on business which previously required several years to produce, and with an expenditure for equipment of not a dollar more than a similar equipment of standard panel signs would have cost. This is the

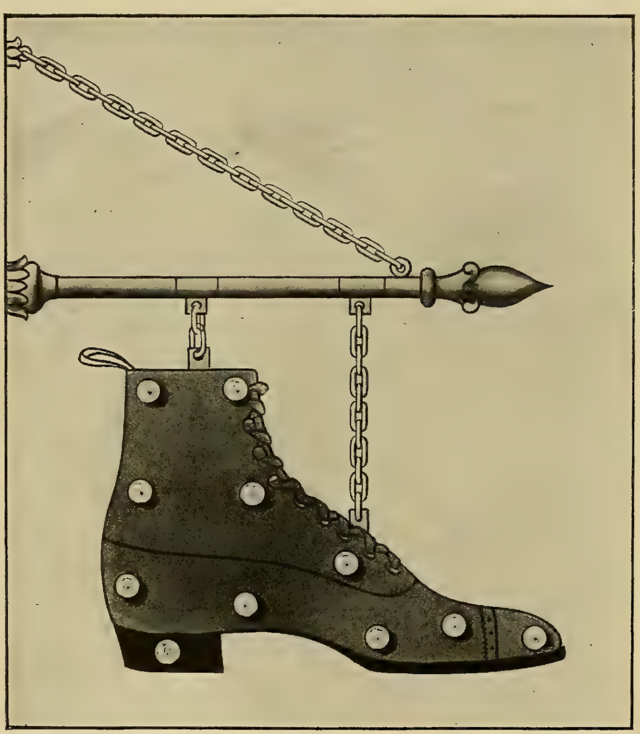


FIG. 4.

effect of injecting "style" in the output of the company, and it has been found to be true that "style" has not only paid in satisfying the customer, but that the station derived sufficient revenue from the additional connected load to more than pay for any possible small additional investment, which had been required.

Some stations have taken the stand that in taking up the sign question on this basis would mean the carrying a stock of many different styles of signs. This does not seem to hold good, as the company spoken of has not found it necessary to carry any additional stock of signs, as the special signs which have been put out on the service have been of such a nature that they could be readily taken down and used for other customers at a small expense for repainting, which expense would, in any event, have had to be incurred on the ordinary panel signs, when used again for new customers.

By making a few simple modifications to the standard individual letter and panel signs, a diversity of style can be made in the sign equipment of a station. For instance, take the individual letter sign of standard type (see figure 1): modify this slightly by combining it with plain block or script letters (unilluminated) (see Fig. 3), by adding a reflector to it, and you have a special sign of a strikingly individual nature, which strongly appeals to your prospective customer and to the public.

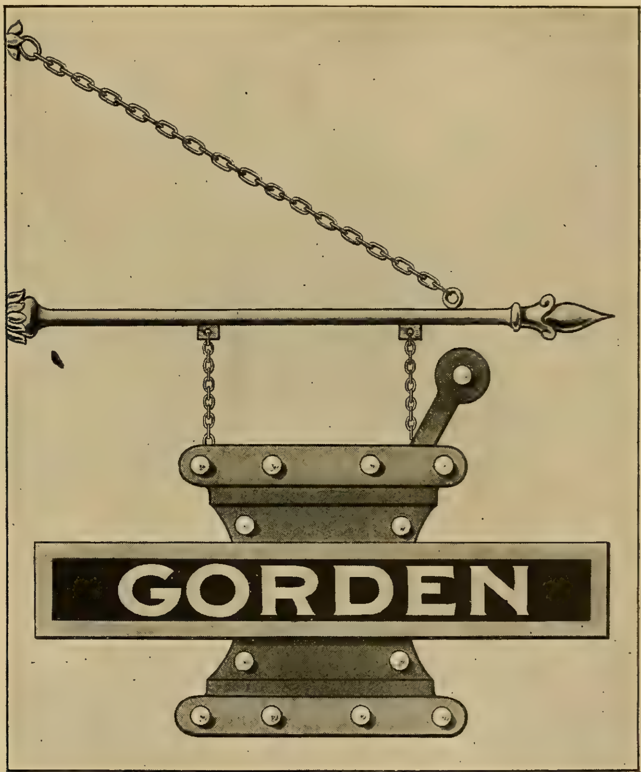


FIG. 5.

Another quite recent novelty is a sign which is made entirely of glass; the background being either black,

blue, or red plate glass, overlaid with mirror glass letters with beveled edges, making a very handsome and artistic, as well as a novel appearance. As yet only one or two stations have given any attention to it at all, although it is a very striking novelty, and has been a great business getter where introduced. One or more signs of this kind in a city would certainly give a distinctive style to the sign output and bring business.

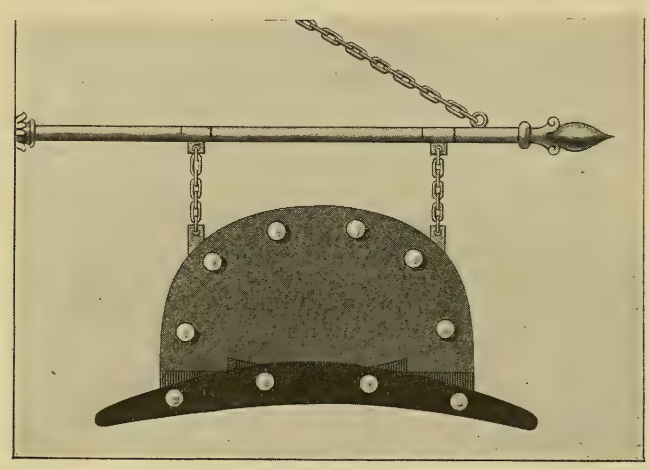


FIG. 6.

In taking up style for panel signs, it has been found that a most satisfactory method is to approach special lines of trade with a single design for each trade. For instance, in dealing with the shoe trade, a sign made in the shape of a shoe outlined with 24 4 c. p. lights (Fig. 4) has been found to be very satisfactory, and in 20 cases where an ordinary sign could not be sold to customers in the shoe trade, this sign has been successfully placed. For the drug trade, a sign in the shape of a mortar and pestle with the customer's name painted across it (see Fig. 5) has been used in an equally successful manner. Again, the hat trade has been reached with a hat, containing 24-4 c. p. lamps(see Fig. 6). The jewelry trade has been brought in line by taking an ordinary round panel sign, painting the face of it like a watch dial and putting a ring on the top of it like the ring of a watch, and then painting the customer's name across the face (see Fig. 7.) For the saloon trade, a standard round sign has been taken, painted like a barrel head, a spigot put in each side of the sign, and the result has been an ideal sign for this class of customer. These modifications are only a few illustrations of the many changes possible, and it will be seen that in almost every case the signs would be equipped with the same number of lights as the standard panel sign of a similar size and type, and would be installed in exactly the same manner, on the same terms and conditions. In the event of a change in lettering, etc., being necessary, the work could be readily done for a new customer in the same line of business at slight expense. As before mentioned, the signs illustrated have been used to meet such a situation, and the problem has worked out so successfully that the results would seem to fully combat the

prevailing idea that a central station would be liable to overstock with special signs if such a proposition were undertaken.

The impression seems to be quite general that when standard signs are put out on the free sign basis all has been done that could be reasonably expected, but that this impression is radically wrong is being slowly but surely realized. It has been found that the cities having the fewest signs on their service are cities where the free sign policy has been limited to the supply of only standard signs, while the cities having the greatest number of signs on their system in proportion to population are those where the central stations have met the problem successfully and given the prospective customers what they wanted by supplying any number of special style signs desired to them. It must be remembered that the electric sign is like any other advertising proposition. It must be "originated, cultivated and then followed closely to completion," but above all the sign itself must be original in design and distinctive in effect to give the advertising results it is intended to produce. To do this there is but one successful method. Make "style" predominate in your output. Make each sign not only advertise the customer, but advertise itself, and your station. Then and only then you get the sign business you ought to have. The whole secret lies in two things—INDIVIDUALITY and STYLE.

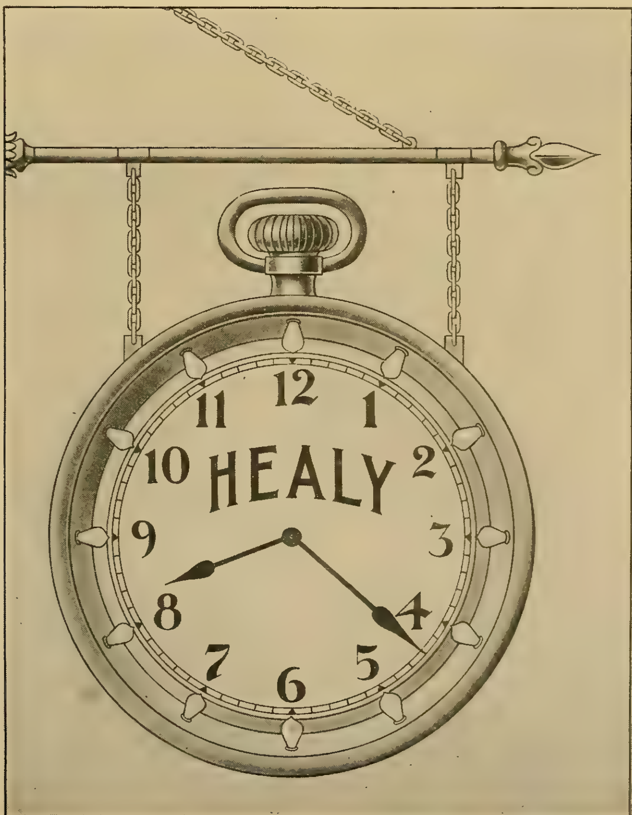
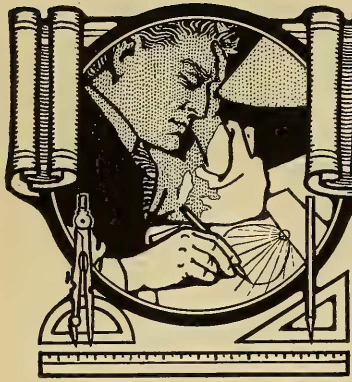


FIG. 7.



Practical Problems in Illuminating Engineering

Illumination of an "Opera House" in a Small Town

By Wm. A. Murray.

The electric lighting equipment which is described in the following was installed in a building that is occupied as an amusement house and dance hall.

The parts of it which were illuminated consisted of an auditorium, stage, two dressing rooms adjoining the stage, main stairs and landings, front of entrance to the building, and two small rooms on first floor.

The first consideration in regard to the lighting was given to the auditorium, which consisted of a space 50 feet long by 39 feet wide, 16 feet between floor and ceiling, and finished with plastered side walls and ceilings which are painted a slightly dark color.

On account of the character of the space to be lighted it was not thought advisable to arrange the lamps (excepting on the stage), so as to secure a special illumination in any particular part, but to secure a general illumination which would be sufficient in quantity, uniform in brilliancy, come from overhead, be thoroughly diffused, and free from the disadvantages and ill effects due to glare.

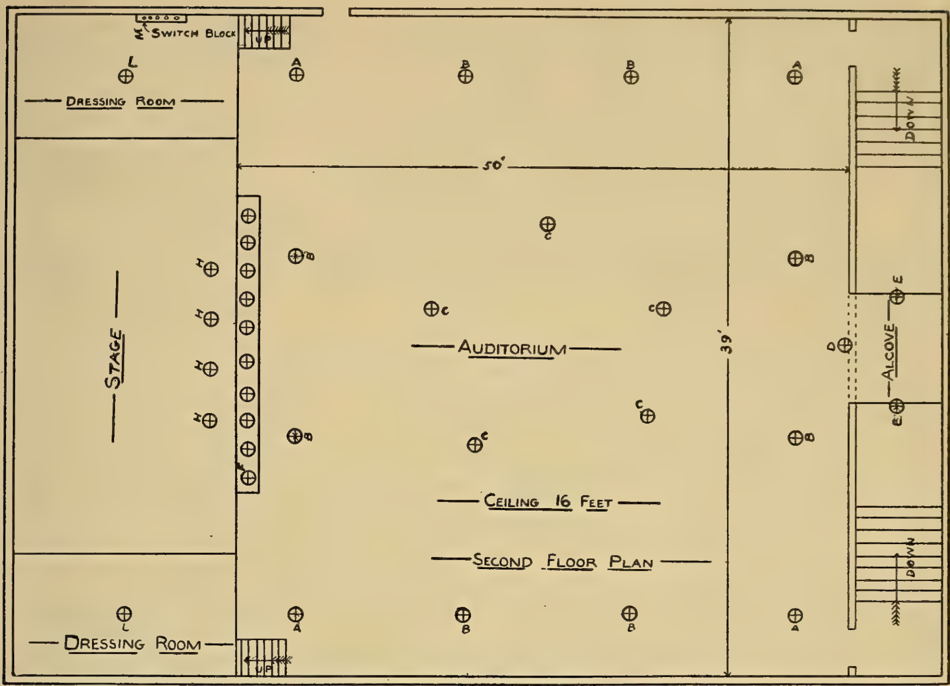
A brief discussion is given of a few of the different plans of arranging the work which were considered, and the reasons why they were discarded in favor of the plan adopted.

For illuminating the auditorium the plan of using chandeliers extending to within a reasonable distance of the floor, was considered and discarded, for the reason that it was believed that this plan would give a light which would be brilliant at the points near the chandeliers, and the spaces not reached by the full light from them to appear less brightly lighted, thus defeating one of the principal qualifications sought, viz., uniformity.

The plan of using side lights on the walls was not given very serious consideration for two reasons: first, it was believed that the light given would not have sufficient strength to penetrate the whole space across the auditorium; and second, on account of the construction of the building it would be somewhat troublesome to install them.

Another plan which was considered was to divide the whole ceiling space into squares, placing a light in the center of each square. While it was thought that this plan would secure a desirable arrangement in regard to illuminating effects, it would no doubt require an undue amount of wiring, and besides it was thought that it would give an effect in arrangement which would not be pleasing to the eye; for these reasons this plan also was discarded.

Finally, the following plan, after



careful consideration, appeared to possess the features which would secure the results sought, and was therefore adopted.

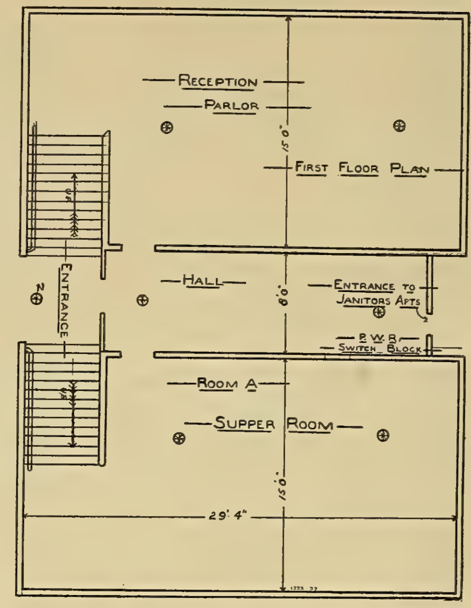
This plan consisted of an arrangement of lamps placed directly against the ceiling, wall sockets being used. The position of the lamps, and the arrangement of the circuits is as shown on the plan. On first thought it was believed that on account of the distance between floor and ceiling, 16 feet, a greater number of lamps would be required to secure a sufficient amount of illumination than if the lamps were arranged on chandeliers extending to a point within a reasonable distance of the floor; so the plan would be open to criticism on account of the increased cost for current. Experience has shown, however, that this plan of lighting spaces of the character described secured a general illumination which was entirely satisfactory in every respect, and which possessed the desirable features sought. A test proved that a newspaper could be read with perfect ease in any part of the space illuminated.

In the auditorium rows of lamps are placed around the ceiling at a distance from the side walls of about 4 ft. This arrangement was supplemented by the use of a group of 6 lamps forming a hexagon in the center of the ceiling.

The lamps are arranged on 3 different circuits to permit of a partial lighting of the room when desired. The switchboard controlling the auditorium was located in the men's dressing room, which was considered the most convenient point for the one who would operate it. In order that the janitor or anyone else entering from the other end of the building, might be able to have sufficient light to go about, a single lamp, in a 12-inch silver reflector, was placed in such a position (see plan) as to throw its light over the entire auditorium. This lamp is controlled by a switch located

at the entrance to the janitor's apartment. The hall lights are also controlled by a switch at the same point. The foot-lights are placed in a trough sunk so that the top is flush with the floor of the stage. This was done to avoid obstructing a view of the stage floor. The trough is lined with polished sheet metal. The lights are controlled by the switchboard in the men's dressing room.

Additional light for the stage is provided by the use of 4 lamps on the ceiling immediately back of the curtain. The dressing rooms are lighted by the use of one 16-candle-power lamp in each, placed on the ceiling. The entrance stairways are lighted by the use of one lamp placed in an angle socket on the wall, as indicated in plan. This was somewhat of an experiment, but in case the 16-c.p. lamp did not give sufficient illumination, it would be an easy matter to substitute a 32-candle-power lamp. These lamps are also controlled from a switch near the janitor's apartment. The landing at the bottom of the stairs is also lighted by one 16-c.p. lamp on the ceiling. The room designated as A on



the plan is lighted by 2 16-candle-power drop lights, and a 16-candle-power lamp lights the first floor hall. Holophane reflectors are used throughout. The installation has now been used for a sufficient length of time to warrant a statement that the illumination has proven entirely satisfactory.

Studies of Notable Instalations

The Knickerbocker Hotel, New York

BEDROOM SUITES.

The Hotel Knickerbocker stands at the corner of Broadway and Forty-second street, diagonally opposite the towering triangular building of the *New York Times*. It is the most recent addition to New York's skyscraper palaces, and, in many respects, is the most elegantly furnished and appointed of all. In architecture the building is of French Renaissance, and is built of red brick and light gray limestone.

The lobby is furnished in light marble, with a decorated ceiling in which light neutral tints are set off with an abundance of gilding. A mezzanine runs along one side, and is screened off with a lattice and curtain, as shown at the left of the illustration. The fittings at the desk, as well as the lighting fixtures, are of bronze. The general illumination here is from square lanterns suspended from the centers of the panels. These lanterns are simple in design, as shown, each containing a cluster of 16 candle-power frosted lamps in an upright position. These lanterns are open at top and bottom,

and have plate glass sides. Brackets supported from heavy bronze plates are attached to the pilasters, each bracket bearing two imitation candles fitted with candle shades over miniature lamps. The illumination is sensibly uniform and of a very satisfactory degree of intensity.

The lobby is flanked by dining rooms, a café occupying the Broadway side, the main restaurant the forty-second street side, and a room called the "Flower Room" adjoining the main restaurant in the rear. The café is finished in white and gold. The illumination is from chandeliers of

CAFÉ.

bronze richly ornamented with crystal glass pendants. Side brackets supporting candle lamps are attached to the pilasters. The white and gold finish renders the room easy of illumination.

The main restaurant has a wooden ceiling finished in a soft fawn color; the side walls are hung with exquisite tapestries. The illumination is by crystal chandeliers supported at the intersections of the ceiling beams. The fixtures contain imitation candles and also plain 16 candle-power frosted lamps. Candelabra brackets are attached to the pilasters. Two electric fountains of white marble of surpassing beauty of design and execution furnish a decorative novelty in illumination that is entirely unique.

The Flower Room is practically a part of the main dining room, being similar in general finish, but distinguished by a magnificent marble urn filled with flowers and ferns adorning

LOBBY.

FLOWER ROOM.

MAIN RESTAURANT.

the center of the room, while a mural painting, "The Pantomime of Flora," covers nearly the entire wall on one side. This is lighted with a row of lamps placed in the angle of the ceiling, and a supporting beam. The light reflected from this brilliantly colored painting gives the effect of looking into the actual open, and is peculiarly pleasing.

The foyer is on the second floor, and is decorated in red and gold. The illumination is by crystal chandeliers of elaborate design suspended from the centers of the ceiling panels.

The banquet hall is on the same floor. It is finished in pale blue, silver, and white, and affords accommodation for five hundred guests. A gallery encircles the entire room. The illumination here is by all crystal fixtures, containing electric candles and incandescent frosted lamps. The private dining room of state is furnished in green and gold and is lighted by crystal fixtures ornamented with a profusion of bead work and cut pendants. Each fixture supports six tall candles and contains lamps within the bead work balls. Candelabra brackets are also placed upon the side walls. Opposite this state dining room there are a number of other dining rooms of various sizes equally sumptuous, in which the il-

lumination is by crystal fixtures generally similar in design.

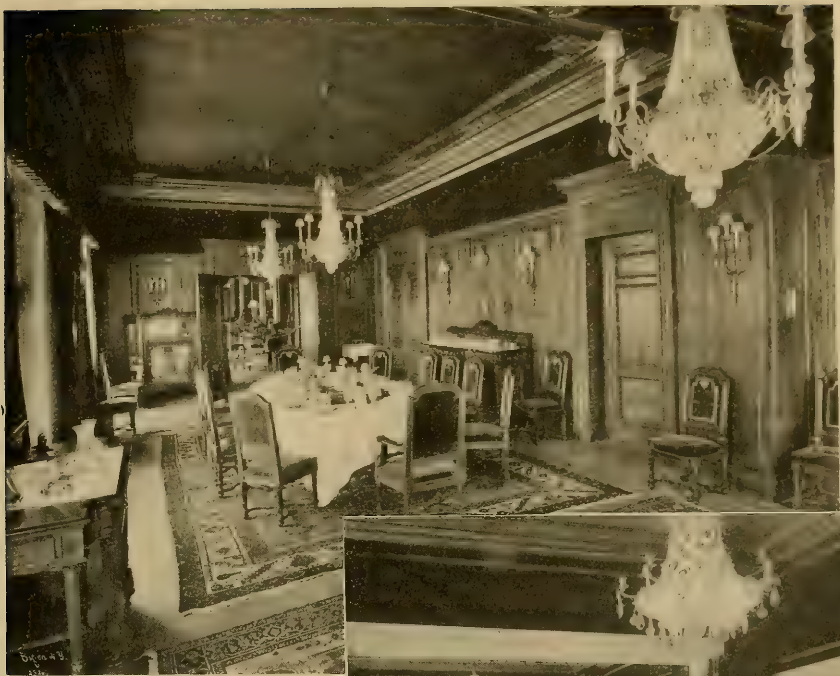
A large grill room is located in the basement and is reached directly through a corridor leading to the subway station. This is finished in English oak, the illumination is by chandeliers and wall brackets of Flemish design.

The bedroom suites are lighted with chandeliers of bronze decorated with crystals and supporting candles in shades. Table lamps and candelabra brackets add to the decorative appearance. The individual bedrooms receive their general illumination from a four-light electrolier on the ceiling, while special light for dressing is furnished by side brackets at each side of the mirror; a table lamp affords a convenient reading light.

Practically the entire fixture installation is of French workmanship, and displays the finished workmanship and exquisiteness of style which are the well known characteristics of French artists and artisans. It is probably the most expensive fixture installation in New York City, at least in any hotel. It is noteworthy that the most elaborate specimens depend largely for their artistic effect upon the use of crystal glass in various forms. Metal where used is in all cases plainly subservient to its legitimate purpose as a support for the lights and crystal pendants. The plentiful use of devices to simulate candles, the effect of which is hidden by the use of dainty candle shades, is a characteristic feature of the entire installation. So daintily exquisite are

BANQUET HALL.

GRILL ROOM.



PRIVATE DINING ROOM OF STATE.

PRIVATE DINING ROOM.

the fixtures in design and workmanship that to analyze them as to number and candle-power of the lamps contained and the efficiency secured in watts per square foot, seems akin to the process of plucking apart the petals of a rare flower in order to determine its botanical classification.

The entire furnishing of the hotel has been carried out absolutely regardless of expense, and therefore in considering the illumination the question of economy is hardly worth mentioning. The fixtures are a worthy part of the general magnificence, and while masterpieces of art in glass and metal, nevertheless fulfil their manifest purpose of supplying illumination, and accomplish this without an evident disregard of efficiency. In short, they furnish an illumination satisfactory from every point of view, and are in themselves objects d'art, and no higher praise can be bestowed upon a lighting fixture.

Theory and Technology

Plain Talks on Illuminating Engineering

By E. L. Elliott.

IX. Location of Light Sources: Special Considerations

In the February issue we discussed some of the general conditions which have an important bearing upon the location of light-sources. The views therein expressed may be summarized as follows:

Illumination may be divided into two classes: first, general illumination, which seeks to produce as nearly as possible an equal intensity over a given surface or throughout a given space; second, special illumination, which aims to produce special light in special places for particular purposes.

Diffusion applied to light refers to the different directions of rays at a given point. A perfectly diffused light is one in which rays of equal intensity cross in every direction at every point. Perfect diffusion is not desirable in any case. The most desirable diffusion is one in which at every point there is some light from every direction with a preponderance of intensity from a single direction.

Equal uniformity of intensity over a given surface can be produced by the use of either small or large units supplied with the proper distributing accessories.

Large units may be used in large spaces. As every unit is a conspicuous point, an excessive number of units calls attention to the light-sources rather than to the objects illuminated. For spectacular and display lighting, therefore, the larger the number of units the better. For general illumination a smaller number of units is desirable.

The location, height, and size of units should be subservient so far as possible to the structural features.

The advisability of using indirect or ceiling lighting for illumination where careful eye work is to be done has not yet been conclusively proven. This method of lighting should be used with due caution and conservatism.

The proper location of the lighting units is perhaps the most generally important problem with which the illuminating engineer has to deal. Besides the general considerations which have been enumerated, there are always more or less special conditions, a consideration of which must determine the actual location of the units. In cases of electric lighting the wiring problem will naturally come in for consideration; but in this respect the former practice has been of the cart-before-the-horse order; convenience in wiring has been the predominant factor in determining the location of outlets. The ultimate object of wir-

ing is to secure artificial illumination. The wiring is, therefore, only a means to an end, and should always be considered in this light. The wiring involves only original cost, which is an item of investment, while the illumination is a continuous charge; and it requires no high financier to see that even a very small continual expense may soon overbalance a proportionately high percentage of difference in first cost. Unless the system of units giving the most desirable illuminating results gives rise to excessive difficulties and expense in the way of wiring, it should not be discarded for a less satisfactory system which can be had at a somewhat less cost of installation. We fully realize the difficulties of bringing the average architect and owner to accept this view of the matter, and no doubt compromises will need be made for sometime to come; but if the principle is correct, as we believe it is, it must prevail sooner or later, on the general law of the survival of the fittest.

As special conditions will arise with every different problem, it will be impossible to state all these conditions categorically. The more useful procedure will, therefore, be to take some typical cases for discussion. The modern office building represents in some respects the most complicated conditions of any illuminating engineering problem. The chief difficulty in the way of locating the units is the fact that, in a large number of cases, the rooms as originally provided in the plans are partitioned into more or less smaller rooms, and these partitions change with the various tenants. The problem of how to produce an elastic system capable of adapting itself to these changing conditions is apparently not an easy one to solve. In the past practically no attempts whatever have been made toward a solution; and as a consequence the office building has generally the most faulty illumination of any class of building. We have in mind one instance of a very large building—said to be the largest in the world—in which the only illumination provided was from side brackets; and except in a few offices that had been originally planned for special purposes, there was not a ceiling outlet in the whole building. Furthermore, the lamps on the side brackets were in a vertical position, close to the wall, and pointing either up or down, at the tenant's fancy. Each lamp was supplied with a dense opal glass shade nearly covering the lamp, which threw a comparatively small bright spot either on the ceiling or floor next to the wall, and cut off probably 60 to 75% of the light that should have been thrown out into the room. The result, as may be conceived, was a general illumination so inadequate as to be practically useless. In order to satisfy the tenants, it has therefore been necessary to patch up the lighting by running mouldings from the various side outlets and hanging up clusters or large units, as required, at different points on the ceiling. It thus happens that a side outlet originally wired for a two-light bracket was made to carry a 6 or 8 light cluster; and after the installation of such additional lamps throughout the building, the mains and switches run at a temperature which would give an insurance inspector or electrical engineer a nervous chill.

Another case exactly the reverse to this came to our attention very recently, in a prominent office building not yet completed. In this, ceiling outlets are provided to the entire exclusion of side-wall outlets. As a result, it will be impossible for any tenant to have a desk light—an absolute essential in good office illumination—with-

out the makeshift and awkward method of running a flexible cord from a chandelier. To take one particular case: a tenant who took one of the offices was obliged to have moulding wiring done on the ceiling in order to properly light the several offices into which he divided the space, before he could occupy them.

Both classes of lighting, that is, general and special, must be provided in an office if satisfactory results are to be attained. There are some illuminating engineers who advocate the production of a general illumination of sufficient intensity for the special purposes of office use, but this contention is by no means generally accepted. There can be no question as to its being far more expensive than a combination of the two methods, and we believe the consensus of opinion and experience is against the exclusive use of general illumination for office use. The most economical, and we believe, the most satisfactory method of illumination is obtained by producing a mild general illumination, which can best be secured by units attached to the ceiling, and providing special illumination by means of desk and table lamps. In order to supply the latter, side wall outlets should be provided. These may be utilized as outlets for brackets, or separate receptacles may be provided. The location of the ceiling lights must be such as to provide for general illumination not only in each room as a whole, but for any number of smaller rooms into which the space may be divided. This latter problem is not so difficult of solution as might at first appear. There are certain structural features in every room, such as windows, doors, and supporting columns, which will practically determine the possible combination of partitions that can be used. Let us take the example of the case mentioned: The

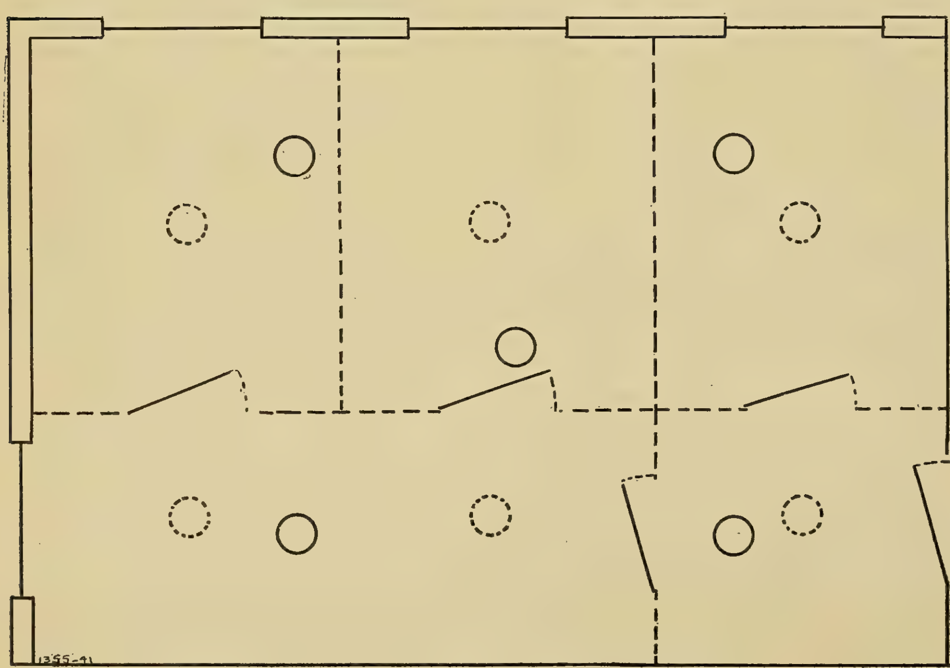


FIG. 1.

plan of the room is shown in Fig. 1 by the solid lines, and the solid circles show the location of the ceiling outlets as originally provided. The subdivision of the room into four small offices and a vestibule is indicated by the dotted lines; the moulding wiring and location of outlets for this arrangement are also indicated by dotted lines. It will be seen that the electrical engineer, or whoever was responsible for laying out the wiring, simply jotted down five different outlets placed approximately symmetrically with the room; if called to account, he would probably at once claim that he could not be expected to know how any particular tenant would want to divide up the office. A little study of the structural conditions, however, will show that it is practically necessary to place partitions along certain lines, and within comparatively narrow limits, and that they could not with any sense or reason be placed otherwise. Thus, a partition would never, in the nature of things, be so placed as to divide a window. This condition restricts them to the positions between windows, a position which is comparatively limited. Furthermore, the rooms must all be provided with entrances, which further restricts the line of partitioning. The arrangement shown doubtless represents the maximum number of rooms into which the office would ever be divided. The location of a ceiling unit approximately centrally placed in each of these rooms will, therefore, provide general illumination for this maximum division. But suppose that a less number of rooms were wanted: it is hardly conceivable that the location of the partitions would be materially changed, the only difference being that one or more of those indicated would be left out; but with the arrangement of offices as shown, the leaving out of any partition will still leave the larger room thus formed with lighting units symmetrically placed, and therefore adapted for general illumination.

This example may furnish a general rule to be applied in all similar cases, namely: divide the room into the maximum number of smaller rooms admissible under the structural conditions; arrange a ceiling outlet for each of these subdivisions, conforming as nearly as possible to symmetry with the entire space and with the individual spaces; provide at least one side outlet in each possible subdivision.

The location of the side outlets will depend largely upon the extent to which the owner of the building can be made to realize the importance of artificial lighting. A most excellent plan which recently came to our notice consisted in running a "chair-rail" about three feet from the floor entirely around each office; at various points along this rail flush receptacles were placed. This method may be considered the highest degree of perfection for the required purpose. The next best method is to place receptacles at various points in the baseboard. Where neither of these methods can be used on account of the expense, recourse will have to be had to side outlets provided ostensibly for brackets. The average owner or architect would readily accede to the demand for side brackets, although he might at once shy at receptacles in the baseboard or chair rail.

While the failure to locate outlets to meet the comparatively unknown requirements for office spaces liable to subdivision has some shadow of justification, there is absolutely no forgiveness for a failure to take into account

known conditions, such as the permanent furnishing and equipment of the room. This frequently occurs in the case of public buildings. To be sure, the practice of laying out a public building, first for its exterior architectural appearance, and second, to provide a certain amount of floor space which is cut up into rooms of what are considered proper size, and when the "job" is completed, allowing the various officials to select their room in order of their rank, is one of the idiosyncrasies of American policy with which it is difficult to deal; but this does not hold in all cases. In many instances, perhaps the majority, the particular use to which the rooms are to be put is known when the plans are laid out; and yet in such cases it is not infrequent to find the lighting units distributed with sole reference to geometrical symmetry, and totally regardless of the special requirements of the room. We pointed out some grotesque examples of this kind in the Pennsylvania State Capitol, the equipment of which has produced a political scandal of no mean dimensions. Thus, in the room used by the Auditor General, which contained a number of stacks used for document files, and a large number of standing desks, it happened that two of the ponderous and expensive bronze chandeliers came between two of the filing stacks, the space in the aisle between the stacks affording scarcely enough room for them to spread their massive arms, while the intermediate aisles were left in total darkness. As for the Accountants' desks, some had chandeliers over them; some had chandeliers between them; and in all cases an accountant faced a large number of lamps. In several of the other rooms filing cases were placed against the side walls, and in order to make room for the side brackets, large blank spaces were left in the filing cases, and the bracket brought out flush with a front of the case and in the middle of the blank thus provided for it.

The new Hall of Records in New York City—a building, by the way, of modest dimensions, but costing more than the magnificent building of the Congressional Library in Washington—exhibits some of these same absurd features in the placing of light-sources.

It is not uncommon to find similar absurdities even in the lighting of public libraries; and in ordinary residences the same faults are not wanting in many cases, that is, of placing the light units with reference to the shape of the room, regardless of the location of the furniture. It is thus often impossible to get the proper light to see in a mirror, or for use on a reading or writing table; while a side bracket thus located at random may prevent placing a certain piece of furniture in the most desirable position.

A curious example of the location of light-sources regardless of structural conditions is exhibited in the new City Hall of Newark, New Jersey. The lighting is by lamps studded on the ceiling. The ceiling plans were given to the electrical contractor; in drawing these plans, the architect's draftsman neglected to indicate the supporting beams. As a consequence, the rows of lamps were laid out symmetrical with the side walls only, and thus outlined panels of their own, regardless of the structural panels formed by the architecture.

In illuminating engineering, as in philosophy, a little knowledge may be a dangerous thing.

Daylight Illumination

By O. H. Basquin.

VI. Sky Illumination

(Continued.)

ILLUMINATION ON A HORIZONTAL SURFACE.

In the discussion of the illumination at a point on a window surface it has been tacitly assumed that the window in question is vertical. Sometimes it is desirable to find the illumination on a horizontal surface. This applies particularly to the space occupied by the pavement-lights or vault-lights which are fixed in the sidewalk and allow daylight to pass into basement rooms under them and in their rear. It is becoming the fashion for cities to demand of property owners a certain rental for such occupied space as lies in the public streets. As cities become older and as certain natural advantages become better appreciated it is quite possible that this rental for sidewalk area may bear some relation to the illumination available. As it is, the renting value of basement rooms bears a very intimate relation to their daylight illumination. As we proceed we shall find other supplementary uses for the illumination on a horizontal area.

Fig. 23 shows a projected sky chart for horizontal surfaces. The curves in this figure are precisely the same as those in Fig. 2, page 14, March; they are, however, named and numbered differently. In practice one may use the larger figure for these solutions if he clearly understands the interchanged meanings which the curves assume.

In studying Fig. 23 let us assume that we are considering the illumination of a point, *A*, in a sidewalk close to the vertical face of a building. We imagine our sky drawn as the surface of a sphere with this point, *A*, as the center. We wish to find the projection of this sky upon the horizontal plane.

The vertical building face cuts the sky-sphere in a curve whose projection is the straight line *LZR*, Fig. 23. A vertical plane through the point *A* and at right angles to the face of the building has a line of intersection with the sphere represented in Fig. 23 by the straight line *ZF*. The point *F* has previously been called the front point. Other vertical planes through the point *A* and deviating from the last plane (*ZF*) by 10°, 20°, 30°, etc., are represented in the projection by the straight lines drawn through *Z* and making the corresponding angles with *ZF*. These radiating straight lines then represent vertical edges of buildings. In describing Fig. 2 the same set of radiating lines which there represented the receding edges of buildings were mentioned but they were not drawn in that figure. In both figures these straight lines represent building edges standing at right angles to the plane on which the projection is made.

The semi-ellipses in Fig. 23 which have *LR* as their major axis, *e. g.*, *L*-80°-*R*, represent the horizontal tops of building fronts parallel to the street.

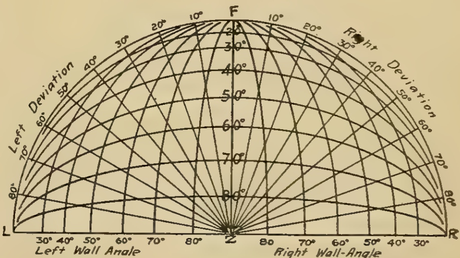


FIG. 23.

These buildings are commonly on the opposite side of the street, though the obstruction of a wide cornice or balcony overhanging the sidewalk would be found by means of these same curves, and in fact, in one sense, the straight line *LZR* is really one of these ellipses. These curves have the same meaning as the same curves in Fig. 2, but it must be distinctly noticed that they are numbered in the reverse order. This is because the zenith-point and the front-point have interchanged places in the two figures on account of the change of 90° in the position of the plane on which the illumination is required.

The semi-ellipses in Fig. 23 which have *FZ* as a semi-major axis, *e. g.*, 80°-*F*-80°, represent the horizontal tops of building-walls which stand at right angles to the street. In the explanation of Fig. 2 such edges of buildings were called receding edges. The same curve of Fig. 2 represented vertical edges of buildings. In Fig. 23 the angular height of these walls at right angles to the street are given by the numerals along the line *LR*. Such a wall angle is defined as the angle with the horizontal made by a plane passed through the point, *A*, for which the illumination is required, and through the top of this wall. It must be measured in a plane at right angles to the wall. If the wall is 20 ft. high above the point *A*, and if the point *A* is 20 ft. from the plane of the wall, then the wall-angle is 45°. This angle is the same irrespective of the length of the wall or of the location along its line of the actual wall.

If the point *A*, for which the illumination is required, is not close up to a building front, then the top of the building front will not be properly represented by the straight line *LZR* in Fig. 23, but will be represented by an arc of an ellipse similar to *L*-80°-R, but on the opposite side of *LR*. Evidently Fig. 23 represents only half of the complete chart for the illumination of a point located anywhere on a horizontal surface. We have drawn only the half-diagram because we at the start assumed our point near a building front. With this understanding we have introduced right and left deviations and wall angles. We may obtain the other half of the complete chart by turning Fig. 23 so as to be wrong side up and interchange the words "right" and "left" thereon. In this position *F* represents a back-point in place of a front-point.

Fig. 23 must be thought of as a ground plan of the projection while Fig. 2 is thought of as a rear view of the projection on the window surface. In Fig. 23 we stand outside and look down, while in Fig. 2 we stand behind the window and look out. This is equivalent to saying that we represent the sky as in the second quadrant of descriptive geometry.

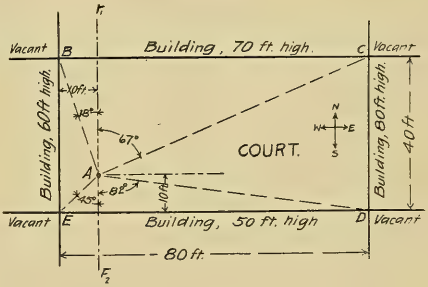


FIG. 24.

In illustrating the use of this chart let us consider the court whose ground plan is shown in Fig. 24. It is 40 ft. wide and 80 ft. long, and is surrounded by buildings whose heights are 50 ft., 60 ft., 70 ft. and 80 ft., on the south, west, north and east sides respectively. We wish the illumination on the surface of the court pavement at a point *A*, 10 ft. from both the

south and west walls. One may think of himself as facing north in drawing the principal part of the projected sky diagram, but in drawing the south boundary of the sky he may turn about and face south. In either position his front point will fall upon the line F_1 F_2, Fig. 24. Drawing lines from A to the corners of the court B, C, D and E, and measuring the angles which these lines make with F_1 F_2, we have the angular deviations given in that figure.

Now we may stretch a piece of tracing paper over the chart. Fig. 23—or rather Fig. 2, with the necessary changes understood—and proceed to draw the projected sky-diagram, shown in Fig. 25. In the first

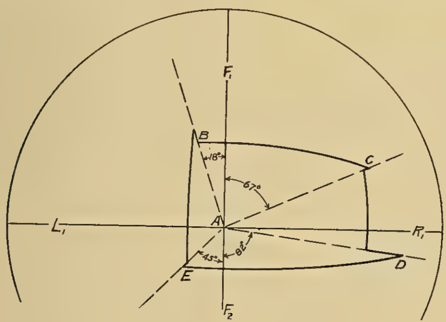


FIG. 25.

place the lines of deviation, AB, AC, AD and AE may be laid off in this figure just as they are in Fig. 24. They represent the vertical edges of the buildings where they intersect to form the corners of the court. These lines are drawn of indefinite length at the beginning.

The building on the north side of the court is 70 ft. high and 30 ft. distant from the point A. The tangent of its angular height is 70/30 or 2.33 which is the tangent of 67°. The angular height of the north side is therefore 67°. In Fig. 25 we may now draw the curve BC interpolated to represent 67° between the curves L-60°-R and L-70°-R of Fig. 23. This curve BC is limited by the lines of deviation AB and AC already sketched in.

On the west side of the court the tangent of the angular height is 6, hence its angular height is 80½°. On the east side of the court the angular height is found to be 49° while on the south side it is 79°. The curve BE is drawn in Fig. 25 just at the right of the curve F-80° (left) of Fig. 23 At the right in Fig. 25 the curve below C is drawn to represent a right wall-angle of 49° as seen in Fig. 23. To draw DE the tracing paper may be removed, rotated 180° and fixed again in place so that the point Z coincides with its first position. DE is now drawn near L-80°-R to represent 79°.

Connecting these curves along the radial lines AB, AC, etc., completes the diagram. Its area may now be taken by means of the planimeter and is found to be 0.97 square radii. If we take 250 candles per square foot as the sky-brightness we find the illumination at A, Fig. 24, to be about 240 ft. candles.

It will be noticed that in Fig. 24 the corners between the buildings are marked vacant. This was done in order to make sure that the vertical edges of the higher buildings would show as a part of the sky outline in Fig. 25. If each of these vacant corners had been occupied by the taller of the two buildings meeting there then in the projected diagram the curves representing the tops of the building faces would have intersected in succession and not on the lines representing the vertical corners of the court.

ILLUMINATION ON AN INCLINED SURFACE.

Not all light openings are included in the two classes thus far considered,

viz., vertical openings and horizontal openings. Nearly all skylight openings have a sloping position and an interesting application of the study of the illumination on an inclined surface is in the comparison of the old-fashioned mirror reflector, set sloping upwards in front of a window for the purpose of deflecting light through it, with the more modern prism canopy used for the same purpose, but set sloping downward and forming a natural protection for the window before it is placed.

In the projected sky charts, Figs. 2 and 23, the edges of the buildings, represented by lines in those figures, have been either parallel to the plane on which the illumination is wanted or at right angles to it. It is only because this plane was shifted through a right angle that the curves of Fig. 23 have the same form as those of Fig. 2. For any other angular difference of position these curves would be quite different. If one were required to find the illumination for a considerable number of cases at any one particular slope for this surface, it would doubtless be a saving of time to construct a chart for that particular inclination. This construction would not be difficult, especially if one has an ellipsograph at his disposal.

It does not seem necessary, however, to go into the matter of constructing these special charts in as much as the following method is good for all inclinations of the surface in question, although it involves the construction of two projections for each solution. The method depends upon the following well-known proposition of solid analytical geometry, viz.:—*The area of the projection of one side of any surface on a given plane may be obtained by first finding the projection of the boundary of that surface upon each of three mutually perpendicular planes, and then finding the projection of each of these areas upon the given plane; the algebraic sum of these doubly projected areas is the required area.*

If we select the three mutually perpendicular planes such that one of them, say the *P* plane, is at right angles to the given plane, then the *P* projection cannot contribute anything to the final area on account of its perpendicularity, hence with this selection of planes we need consider only two projections, viz., those on the horizontal and vertical planes. The surface originally projected may be considered as made up of plane curves parallel to *P*; the projected areas will then be made up of lines parallel to *P*.

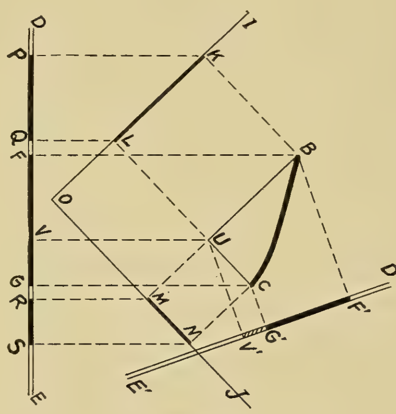


FIG. 26.

One of these plane elements and its projections are shown in Fig. 26. *BC* is the line the length of whose projection on the straight line *DE* is wanted. *OI* and *OJ* are any two lines in the same plane as *BC* and *DE* and at right angles to each other. The projection of *BC* on *OI* is *KL*, while *MN* is the projection of this curve on *OJ*. Projecting these projections now on *DE*, *KL* projects to *PQ* and *MN* projects to *RS*. Now, *PQ* evidently has the same length as *FV*, because they

are projections on the same line of two equal parallel lines, *KL* and *BU*. In the same way *RS* is seen to have the same length as *VG*, being projections on *MN* and *UC*, respectively. Hence we see that the sum of *PQ* and *RS* is the same in magnitude as *FG*, the direct projections of *BC* on *DE*.

In Fig. 26 an alternative position for the line *DE* on which the projection is made is shown at *D'E'*. In this case the curve *BC* is directly projected to *F'G'*. *BU* and *UC* are projections of *BC* on mutually perpendicular lines, but the projection of *BU* on *D'E'* is *F'V'* which is larger than *F'G'*, the direct projection of *BC* on *D'E'*. This means that the projections of *BU* and *UC* on *D'E'* are of opposite signs. We may call *V'G'* negative so that when this line is added to the positive line *F'V'* the resulting line *F'G'* has a smaller length than before. This subtraction of the projections must be made whenever the projection of the point *U* falls outside of *FG*. This matter of judging the similarity of signs can be told at a glance in most cases, but lack of attention to signs will naturally lead to results wide of the mark.

In applying this method to the subject of illumination, *BC* in Fig. 26 represents the sky, *OI* or *UB* represents the vertical plane or window plane, *OJ* or *UC* is the horizontal plane, while *DE* is the sloping skylight, mirror or reflector, set at an angle, , from the horizontal. To find the illumination upon the sloping plane we (1st) find the projected sky-diagram on the vertical plane using Fig. 2; (2nd) find the projected sky-diagram on the horizontal plane using Fig. 23; (3rd) multiply the area of the first diagram by $sin\,\delta$, and that of the second by *cos* , and add, paying attention to the signs of these projected areas; (4th) this sum expressed in square radii and multiplied by the sky brightness is the illumination required.

In making these diagrams one must be careful to include no sky below the plane of the surface on which the illumination is required.

In illustration of the use of this method let us find the illumination on a mirror reflector set at an angle of 50° with the horizontal before a window in the middle of the north side of the court, Fig. 24, and 20 feet from the ground. The mirror is shown in section at Fig. 27 (a). Since the window is so high above the ground, the

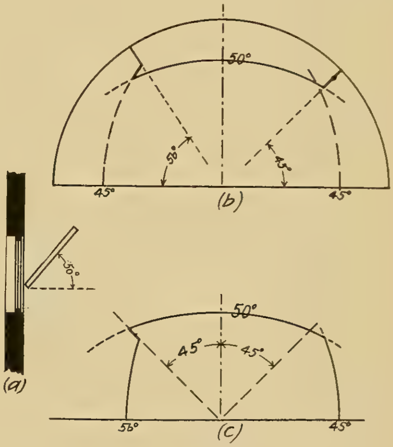


FIG. 27.

angular height of the opposite building is found to be but 37°, but since the mirror is set at 50° from the horizontal and since we are not interested in the illumination on the lower surface of the mirror, we must take 50° as the angular height opposite the mirror set in this position. The wall—angle at the left (east) is 56°, while that at the right (west) is 45°. The angular deviations for the corners of the court, *D* and *E*, Fig. 24, are each 45°. Now using tracing paper laid over Figures 2 and 23, we may draw at once the projected sky diagrams shown in Fig. 27 (b) and (c). The

former, above the curve marked 50° is the projection of the sky on the vertical plane, while the latter below the curve marked 50°, is the projection of the sky on the horizontal plane. The areas of these diagrams are 0.27 sq. radii and 0.72 sq. radii, respectively. These areas are projected on the mirror plane by multiplying them by the sine of 50° (0.77), and by the cosine of 50° (0.64), respectively, giving 0.21 and 0.46 square radii. A little study of the relative position of sky and mirror in this case shows that these projections are of opposite signs, so that we must take their numerical difference, 0.25 sq. radii, as the final area of the sky projected on the mirror plane. Multiplying now by 250 candles per sq. ft. we find the illumination on the mirror due to direct skylight to be between 60 and 65 ft. candles.

If in place of the mirror-reflector we had considered a prism canopy, set at the same angle, but sloping downward in place of upward, we would have found a much larger illumination (1st), because we could have used 37° in place of 50°, as the angular height opposite the window and (2nd), because the two projected areas would then be of the same sign and would thus be added in making up the resulting area.

(To be continued.)

Blondel's System of Arc Lighting

By Isador Ladoff

As is well known, the luminous mineral vapors have a tendency to rise and to separate themselves from the carbon or smoke vapors when current flows from the upper to the lower carbon. The arc in this instance is luminous only in its upper part near the upper carbon. When, however, the composite carbon is placed below the upper negative carbon, the ascending current heats the luminous vapors during the whole of their course and when assisted by the shield or plate 3 this results in an increase of the total luminous flux of from twenty-five to forty per cent. in similar lamps and from 100 to 300 per cent. in other arc lamps. Again, when the composite carbin is placed below it is no longer licked by the flame and hence produces the scoria. The scoria produced runs off the carbon without falling into the arc. The upper carbon being substantially pure, produces no troublesome globules of scoria.

To increase the steadiness of the light, it is preferable in alternating current lamps to place in both carbons a core containing alkaline salts, such as tartrates, carbonates, etc., of sodium or potassium, etc. The combining of a small percentage of light-producing salts with the carbon of the upper electrode is of little value in continuous-current lamps, except perhaps in reducing the consumption of the upper carbon. In alternating-current lamps, however, the combining of each carbon with the light-producing salts assists in increasing the luminosity of the arc. In such instances the lower carbon should contain from thirty to sixty per cent of mineral substance, whereas the upper carbon should contain from but five to twenty per cent of the salts of lime, etc., or a core of large diameter containing a considerable quantity of this substance. In any case the special feature is a composite lower carbon. In addition to the advantages arising from the composition and ar-

rangement of the two carbons the shield or plate around the upper carbon above the arc has several useful advantages. Thus it protects the upper carbon from the action of the flame, the ordinary function of a shield. Again, it condenses on its under surface adjacent to the arc a large proportion of the mineral vapors, which form upon the shield or plate a white reflecting coating or layer. Being of refractory material and having a reflecting surface, the employment of such a shield corrects any appreciable loss of light which might result from placing in continuous-current lamps the positive carbon below the negative carbon, and the effective luminous flux still remains from twenty-five to forty per cent greater than if in a reverse arrangement of the electrodes, even if a shield is used in such reverse arrangement. Its reflecting surface renders the light uniform by diffusing nearly the same quantity at all times in all directions in spite of the displacement of the arc around the carbons. Again, the shield or plate places the arc so that it is protected against cooling and currents of air, holds back the vapors, and renders the arc steadier. Thus, with this arrangement and the carbons arranged in the manner indicated above, steady arcs of ten to twenty-five millimeters and more, under tensions of thirty to fifty volts and beyond this, may be formed, thus obtaining the maximum useful effect.

The smoke consumer, which may be dispensed with in certain cases, consists substantially in a conical or cylindrical flue or chimney surrounding the shield or plate, so as to collect and carry upward by suction through the action of a draft the mineral vapors which escape from it by the lower rims. Holes may also be pierced in the shield or plate, for facilitating this outlet of the vapors; but the chimney produces a useful effect, which would not be obtained by holes alone without chimneys. The smoke-consumer may vary in height or be reduced to a simple collar. It may be employed at the same time as an outer covering for the lamp, Fig. 6.

In general it is an advantage to attach it to the interior cylindrical or conical protecting tube which supports the shield or plate and surrounds the upper carbon, so as to place it beyond the reach of the air or the vapors. The vapors are drawn up into the circular space or flue comprised between the two tubes and can be caused to deposit themselves here almost entirely by means of baffle plates or wire gauze.

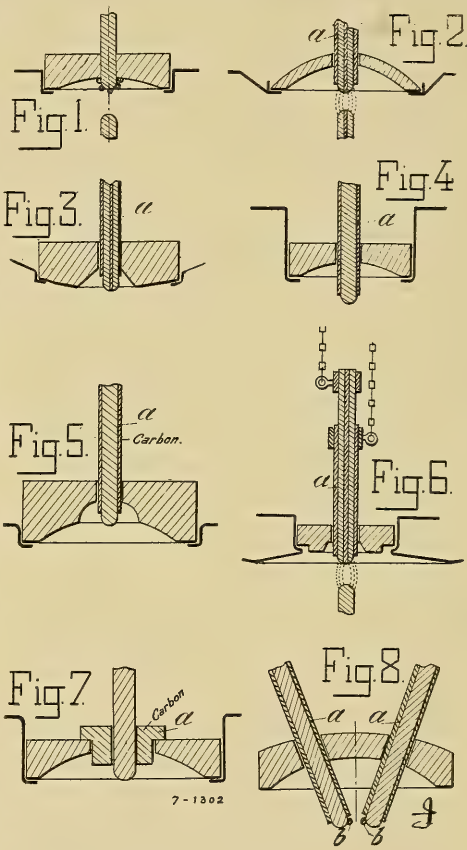
It will be observed that the mechanism contained in the casing box or shell 21 in Figs. 5, 6, 7 and 8 is completely isolated from the mineral vapors. This mechanism may be of any kind upon condition of its satisfying two requirements, viz.: insuring a much greater extension of the electric arc than in ordinary lamps and giving the upper carbon a forward motion proportional to the extent to which it is worn out, which in general takes place less quickly than in ordinary continuous-current lamps, in which the positive carbon is above.

The arrangements described are capable of a number of modifications which do not alter the essential characteristics described above. In particular the smoke-consumer may be plain or enameled, as a reflector. It may have a variety of forms, as may also the shield or plate. The substance of which this latter is composed may also be considerably varied. The baffle plates may be cylindrical or conical or be dispensed with, as in Fig. 6, or, again, chambers for condensing vapor may be placed outside in the covering 12, into which the gases are conveyed for the pur-

pose of condensing them, as shown by Figs. 6 and 8. Likewise the shield or plate may be made, according to circumstances, of plain or enameled metal, porcelain, refractory earth, carbon, lime, magnesia, etc., or a mixture of these substances. The carbons themselves may be formed of a very large core containing a considerable quantity of salts of lime, magnesia, etc., in place of being treated so in the block.

This invention has for its object an improvement by which the amount of mineral substances in the upper carbon (whatever may be its polarity) may be increased if desired. A special disadvantage presents itself in this case, consequent on the formation of scoria around the point of the upper carbon so soon as its mineralization is greater than seven to eight per cent. The scoria forms, as shown in Fig. 1, as swell around the point of the carbon, where it collects instead of falling in drops. This swell thereupon prevents the upper carbon from moving freely upward through the hole in the reflector when striking the arc and when drawing it out by the top when the carbons are changed. Moreover, the scoria may ultimately attack and fuse the refractory material forming the reflector (which may be a dome, crucible, or disk) which surrounds the carbon near to its point. Lastly, it falls in drops upon the point of the lower carbon.

The improvement forming the object of the present invention consists in surrounding the upper carbon with a protecting-envelope *a* of carbon, which not only enormously reduces the formation and fall of scoria, but also forms (in order to allow the carbon to be easily withdrawn) a space between the scoria-forming portion of the carbon and the walls of the hole in the reflector. The said hole may, moreover, be advantageously cut away for a certain distance toward the bottom, forming a conical, spherical, cylindrical, or other enlargement, as shown in Figs. 3, 5 and 6, in order to more surely prevent scoria touching the walls. Figs. 2, 3, 4, 5 and 6 show examples of this envelope in several different forms of reflector. The carbon envelope is consumed little by little and should consequently be fed forward bit by bit. This forward movement



U. S. PATENT 764,105.

may take place in one or other of the following ways:

First.—As shown in Fig. 6, the top of the envelope (which is shorter than the upper carbon) is fixed in an independent annular carbon-carrier, supported by a rod, chain or cord analogous to that which supports the

carbon-carrier of the central carbon and receives through the lamp mechanism a similar but smaller movement than that of the carbon. The said movement is empirically regulated in such a manner that the advance is proportional to the consumption. It is not necessary to enter here into the details of the mechanism, which is capable of numerous forms within the reach of any mechanic.

Second.—As shown in Figs. 2, 3, 4 and 5, the envelope of the carbon, which it surrounds, is so fixed that the envelope advances with the carbon without separating from it. The thickness of said envelope is so chosen that it is consumed as fast as the inner carbon and leaves the carbon always flush with it or projecting a little out from the said envelope. The envelope may even be manufactured together with the carbon and have given to it conducting properties advantageous to the passage of the current and the decrease of consumption, according to the arrangements indicated in Blondel's patent No. 714,277, of November 25, 1902. These carbons then have the advantages indicated in this patent, and also the additional advantages of the combination set out above, which render the employment of the reflector more practical. The envelope may also be made fairly thick when the reflector is quite open, as when disc-shaped, as shown in Fig. 4, or when it is desired that the end of the upper carbon should project still more below the reflector, as shown in Fig. 8, for in these two cases the consumption of the envelope is increased, for the carbon is completely exposed to the free air.

Third.—A last and slightly different solution is for the envelope to form the base of the reflector surrounding the carbon, as shown in Fig. 7, that is to say, this portion of the reflector may be made of pure carbon, which is little combustible if of a graphite-like nature or mixed with small quantities of mineral substances—for example magnesia of non-inflammable substances which form white cinders at the lower surface. Such a piece of carbon consumes slowly and may be easily renewed when changing the carbons. As it is very refractory and not attacked by scoria, it may be placed around the point of the carbon quite near to the arc.

These different arrangements of carbon envelopes placed between the upper carbon and the reflector find application in several cases in which a mineralized arc is used, viz.:

First.—In a continuous-current arc, the positive being above and the negative below, the arc being formed between any carbon, whether ordinary or mineralized, whether homogeneous or provided with a core and with or without an envelope. In this combination the positive is kept hotter than when the arc is inverted; but there may be an excess of scoria if the mineralized portion of the positive carbon be too highly mineralized. A mineralization of twenty-five per cent, for example, would be sufficient.

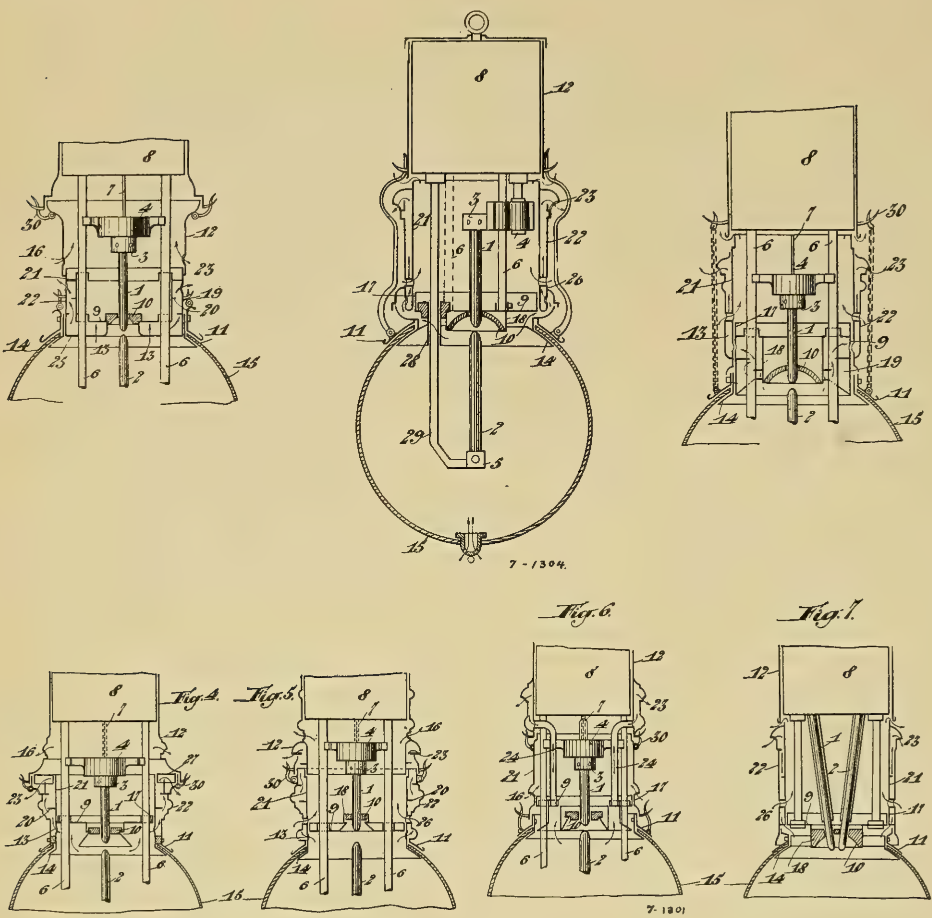
Second.—In a continuous-current arc having the positive placed underneath when it is wished to more highly mineralize the negative, the positive being, if desired, also mineralized.

Third.—In an alternating-current arc having both carbons mineralized.

In all these applications the reflecting dome, crucible, or disc, still possesses the useful properties already mentioned.

Fourth.—Lastly, in continuous-current lamps of any type having any number of carbons mineralized (or in which one at least is mineralized) placed side by side with points downward, Fig. 8.

In this case, again, a notable im-



U. S. PATENT 756,460.

provement in these lamps is effected, for not only does the covering of carbon reduce the fall of scoria and protect the holes in the reflector, as above stated, but it also permits the arc to be formed with safety by moving the two carbons together. In effect, even if drops B are formed the lower portions of the envelope *a* remain clean, and excellent contact may be formed between them when the carbons are lowered until they touch each other.

The object of the invention is to provide an improved construction capable of allowing the escape of the fumes produced by mineralized electrodes without access to the mechanism and the introduction of fresh air into the mechanism and giving easy access for the introduction of the carbon and to generally improve the various parts.

In the drawings of U. S. Patent 756,460, Fig. 1 shows a fixed double envelope 21, 22, which incases the part of the lamp above the horizontal partition 9 and which is traversed by the vapors coming from the lower openings 13 and flowing to the upper outlets 23. Fig. 2 shows a movable double casing which can be separated from the partition 9, upon which it is mounted. Fig. 3, shows a combination of the two above described constructions wherein the double casing 21, 22, is mounted

upon a fixed condensation chamber 18, 19, with the openings 13 opposite to one another. Fig. 4 is a modification of Fig. 2, in which the double casing 21, 22, covers only a part of the height of the lamp. Fig. 5 is another modification, in which the double casing consists of two parts incasing one another. Fig. 6 shows a further construction, wherein the double casing is arranged still higher and receives the vapor through tubes 24 of any desirable number, the lower ends of which extend through the partition 9 and the upper ends of which terminate in the double casing 21, 22. Finally, Fig. 7 shows the application of the same arrangement to lamps with the carbons placed side by side so as to inclose the space containing the carbons and also the mechanism, a double casing 21, 22, adapted for the removal of the vapors being shown independent or connected to the globe or to the base. In these figures the numerals indicate the various parts as follows:

1 and 2 are the carbons.

3 is the upper carbon-holder. 4 is the counterweight accompanying it.

5 is the lower carbon-holder.

6 represents the guide rods of any desired number, one of these being hollow for the introduction of the chain, string, or rod which supports the lower carbon-holder.

7 is the rod, cord or chain supporting the upper carbon-holder.

8 is the closed box containing the usual mechanism.

9 is the horizontal partition which is flat, conical, or curved and consists of refractory material or plain or enameled metal and which completely separates the upper carbon-holder from the zone of the arc in such a manner that no vapors coming from the latter can ascend above the carbon-holder 3 nor reach the mechanism 8. 10 is the economizer supported by this partition 9 or directly attached to the rods 6.

11 is the metal crown fixed above the opening of the globe.

12 is a simple casing surrounding the space containing the upper carbon-holder.

13 represents the outlet openings for the fumes contained in the globes.

14 is an internal collar on the globe (fixed to the latter or to the partition 9 or to the rods) and serving eventually as a reflector, being enameled or not, as in the case of the partition 9, and the economizer 10.

15 is the globe.

16 represents openings for the circulation of the air in the casing 12.

17 is a vertical cylindrical flange of the partition 9, against which the casing is tightly adjusted.

18 is a tubular socket arranged in the partition 9 and carrying the economizer 10.

19 is the fixed condensation chamber mounted upon the partition 9.

20 represents offsets or partitions for cooling and condensing the vapors; 21, 22 concentrical walls forming the double casing or cover between which the fumes escape through the openings 23; 24 outlet tubes which up to a certain height can replace the double casing.

25 is the supplementary partition arranged parallel to the partition 9, so as to form the condensation-chamber.

26 represents tubular openings arranged across the walls 21, 22, of the double casing and having the object of allowing fresh air to penetrate into the lamp without mixing with the fumes.

27, Fig. 4, is a movable annular cover, which can be lifted off the double casing, so as to facilitate the cleaning.

28 is a guide socket in lamps with movable rods 29, Fig. 2, and arranged beneath the partition around the movable rod in order to protect it from

the fumes which settle down upon the socket.

30 indicates the means of attachment—such as bolts, rods, or chains—arranged to connect the various parts of the lamp, globe, casings, base, etc.

As can be seen from the figures, the invention is characterized by the combination with a horizontal partition generally provided with a large economizer of a casing with double walls 21, 22, which are connected together and leave between them a passage for the fumes entering from below and escaping above. These double casings can have a height greater or less with regard to the lamp, and they can be made of one or several parts combined or not with fixed condensation chambers or simple casings. The double casings can be fixed, Fig. 1, or independent, Fig. 2, and they can be held on the base or the globe with the aid of any means of attachment. They can also be connected once for all to the base, Fig. 6, or more conveniently to the globe, Figs. 4 and 5. They fit tightly round the partition 9 either by simple jamming or with the aid of a flexible packing of metal, asbestos, or the like, as used for the joints of any machinery. Their height is sufficient for the production of a draft of gas, and the fresh air can penetrate into the globe through the ash received or through the openings in the crown 11. The openings for the admission of fresh air into the lamp allow of cooling the internal walls of the double casings, and the vapors which traverse these casings between two cold walls are more completely condensed than in any other apparatus. In order to increase the condensation, projections or partitions 20 can be arranged in the casing in the path of the gases, thereby forcing the latter to pass over them, while metallic screens or filters of asbestos, felt or the like can also be used without hindering the discharge of the vapors, as a very powerful draft is obtained. Owing to this draft, the gases do not tend to ascend into the lamp through the joint between the partition 9 and the casing 22; but this joint can be dispensed with according to the arrangements shown in Figs. 1 and 6. In the latter, the simple casings 12 can, if desired, be dispensed with and the space around the upper carbon can be kept open, thus insuring an excellent condensation of the fumes.

Besides the double casings the present invention contains other novel features relating to the arrangements of protectors and economizers. Fig. 2 shows the arrangement of a protecting socket 28. Whenever a lamp has movable rods, they can be arranged so as to traverse the partition 9 with a slight friction through a tight opening provided with packing, which can be of insulating material—such as asbestos, mica, and the like; but this is not sufficient, as in proximity with the economizer the movable rod 29 becomes covered with fumes, which prevent it from smoothly sliding in the opening in the partition. For this reason these rods are at a certain height—for instance, two or three centimeters below the edge of the economizer—surrounded by a sleeve of any suitable material, which can be insulating or electrically insulated from the partition or from the rod. Thus the latter remains clean, and all the fumes can settle only on the protecting sleeve.

Research and Investigation

Conducted by THE ILLUMINATING ENGINEER

The Influence of Chimneys Upon the Efficiency and Performance of Gas Burners

III. The Effect of the Air-Holes

In the preceding tests of chimneys, the purpose was to determine the relative efficiency of the various standard types, both plain and air-hole. The results of these tests showed that the highest efficiency was obtained by the use of a small plain chimney. It is contended, and quite properly so, that the air-hole chimney possess certain advantages over the straight-sided chimney, which should be considered in choosing a chimney for actual use. Foremost among these reasons is the larger diameter of the air-hole chimney, and consequently less liability to breakage from the heat of the flame. In order to determine whether the varying effects of the different chimneys were due primarily to their shape and size, or to the presence of the air-holes, we have had the following tests made:

REPORT ON TESTS OF AIR HOLE CHIMNEYS FOR INCANDESCENT GAS LAMPS.

TESTS MADE FOR THE ILLUMINATING ENGINEERING PUBLISHING COMPANY.

Reports published in the January and March issues of THE ILLUMINATING ENGINEER set forth results of photometric tests of gas lamps equipped with air hole and with other glassware. These reports brought out marked difference in the characteristic behavior of the lamps when equipped with the two kinds of glassware. As the air hole and plain chimneys were not of the same heights and diameters it is not clear whether the differences noted are due to the presence of the air holes in one type of chimney or to the difference in size and shape of chimney.

The tests reported herein were undertaken with a view to determining whether the characteristic performance of the gas lamps equipped with air hole chimneys as compared to those equipped with other chimneys was due primarily to the effect of the air holes or to the peculiar shape characteristic of the air hole chimneys.

The burner, mantle and two of the chimneys are those used in the preceding tests, and are of the following description:

Welsbach Gallery burner, Catalog No. 66, with No. 66 deck plate.

No. 197-J mantle (new).

Clear glass air hole chimneys of the F. Q. M. brand and one mica chimney.

The dimensions of the chimneys are as follows:

Style.	Type.	Max. Diameter.
Glass, air hole..	6¾ in. high	2⅜ in.
" " " ..	9⅞ " "	2⅞ "
Mica, plain	7 " "	2 "

METHOD OF TEST.

As in the preceding tests, only horizontal candle-power values were measured. At the beginning of the test two gasometers were filled with ordinary New York City gas. These suitably loaded, delivered gas to the burner at a pressure of one and one-half inches of water.

Four photometric tests were made with the lamp equipped as follows:

Test No. 1—6¾-inch air hole chimney with deck plate removed and with air holes closed by a strip of mica wrapped

tightly around the outside of the chimney.

Test No. 2—9⅞-inch air hole chimney with deck plate removed and with air holes closed by a strip of mica wrapped tightly around the outside of the chimney.

Test No. 3—7-inch mica chimney without deck plate.

Test No. 4—Same mica chimney as in Test No. 3, but with six 1.2-inch air holes cut at a suitable height and with deck plate installed in gallery.

RESULTS OF TEST.

The continuous line curves shown in the accompanying figure (Plate No. 1855) show the candle-power and efficiency (candle-power per cubic foot per hour) values throughout a range of burner adjustment with the burner equipped as in Tests 1, 2 and 3. The broken line curves shown for the mica chimney are those obtained with the lamp equipped as in Test 4. For comparative purposes the diagram shows curves obtained previously under like conditions with the air hole chimneys used in Tests 1 and 2, but without the mica covering for the air holes and with the deck plate installed in the gallery.

Sufficient tests were made with the air hole chimneys used as such to make certain that substantially the same conditions prevailed as during the previous test from the results of which these broken line curves are taken, thus assuring the validity of the comparison.

The results as shown by the various curves in Figure I prove conclusively that both in efficiency and in the maximum candle-power obtainable, the air-holes are of material benefit. The increase in efficiency in candle-power is greatest in the large chimneys, and of comparatively small amount in the straight-sided chimney. From the series of tests made the following general conclusions may be drawn:

I.—The highest total candle-power is obtained by the use of long air-hole chimneys;

II.—The highest efficiency is obtained by the use of small plain chimneys:

III.—Air-holes increase the efficiency obtainable with chimneys of larger than two inches in diameter.

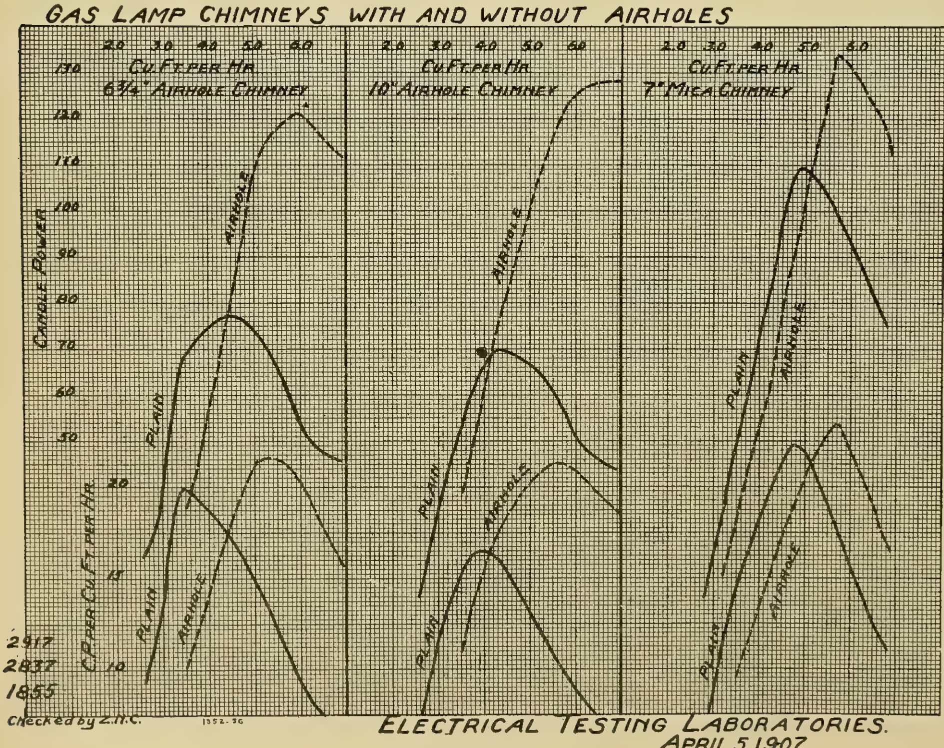


FIG. I.

Editorial

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Illuminating Engineering with Gas Light

In a paper read before the New England Association of Gas Engineers at its recent meeting in Boston, Mr. E. N. Wrightington states a number of propositions which gas company managers should have painted in phosphorescent letters upon their office walls. The portion of his paper dealing with lighting will be found in another section of this issue; but so important do we consider the matters presented that we cannot refrain from using a number of the points that he makes as texts for further moralizing. He says:—

"I am a firm believer in the introduction of a better grade of gas fixture. There is nothing that has hurt the gas industry as a whole quite so much as the poor appearance of the fixtures that have been introduced. The economy of gas has been so over-emphasized that the user has felt that the only reason he was putting up with gas at all was because it was cheap, and he has therefore attempted to economize equally on the cost of the fixtures themselves. The result has been that until recently the gas customer has been only awaiting the time when he felt that he could afford to spend more money for lighting, and then put in electricity, and we have seen in all of our cities the most miserable exhibitions of dilapidated fixtures and broken mantles possible.

"Now that improved fixtures have been made possible, we are selling gas not because it is cheaper than electricity, but because it is better; but the prejudice against gas had become so general that it is slow work to convince the public of its advantages aside from that of economy. This is the prejudice which leads a man to say that although he personally thinks that gas gives a better light than electricity, he is afraid to put it in his store, because his customers will think that his trade is falling off and that therefore he has been obliged to economize on his light."

There can be no denying the exact truth of this statement; and the conditions set forth reveal the weakest point in the gas light industry today. We have pointed out before in these columns, that the advantage of cheapness which gas light has heretofore maintained is being seriously menaced by the recent rapid strides which have been made in the way of higher efficiency in the production of electric light. If the public will pay twice as much for a given amount of illumination from electricity as it would cost from gas, on account of the advantages as to convenience and its more elegant appearance, what will be the result when this difference in cost has

been reduced to one-half this amount, or has disappeared altogether? This is no mere theory, but a condition which the gas-lighting interests must be prepared to face; and the sooner they heed the advice of Mr. Wrightington, the better.

The American fixture manufacturer should also wake up to the possibilities in this direction. The ordinary gas fixture, which has flouted every sense of the artistic since the introduction of gas, has been a thing of ugliness and an eye-sore forever. The European manufacturer has kept up with the procession, and is to-day producing fixtures for both the inverted and upright gas burners, which are the artistic equals in every way of the best efforts in electric fixture design. A number of illustrations which bear out this contention are shown elsewhere in this issue.

The American people are acquiring better taste and higher ideals in all matters of art; and with rapidly increasing wealth, are discarding the ugliness of the old for what is more artistic in the new; and unless gas-lighting follows this general line of progress, it must inevitably lose its position as a serious competitor of electric light, and degenerate into a mere make-shift, to be used only where electric lighting is impossible.

Mr. Wrightington also makes the following very pertinent comment:

"We should go more into matters of illuminating engineering. We should study the distribution curves of the gas lamps, especially the new inverted lamps, with a view to showing prospective customers how to lay out their lighting to best advantage."

All the larger electric lighting companies at the present time are making serious and earnest efforts in the way of illuminating engineering, and either employ consulting illuminating engineers for especially important problems, or are training members of their own force for this work. So far as we are aware, the gas companies are entirely ignoring this important advance in the lighting industry, and have allowed their competitors to steal a march upon them and gain a strategic position, which it will require quick maneuvreing to offset.

A Field for Ambitious Wiremen

Commenting on the general subject of illuminating engineering, the *Electrical Magazine,* of London, makes the following suggestions which are worthy of the attention of American electrical wiremen and contractors:

It seems that the dissatisfied wireman needs no longer consider his position hopelessly restricted. There is no reason now why the ambitious young fellow should not enter upon wiring and installation work with the full intention of subsequently making it his business. Given the present higher goal for his ambition, the position of affairs is altered to an extent meriting the expenditure of time and money on a systematic course of training leading up to this object. The improvement is to be gained by including the study of illuminants and their disposition in the range of subjects entering into the wireman's training. An early and extensive experience in wiring work forms a most suitable foundation upon which the results of subsequent investigation and study in illuminating engineering can be effectively raised. The inclusion of the science and art of illumination in the field of practical wiring supplies the much-desired incentive to a class of electrical workers which has hitherto been quite unable to specialize in its own particular sphere. We cannot commend too strongly this new phase of electric lighting to our readers of the wiring and artisan classes.

There is a certain class of illuminating engineering problems with which the wireman and electrical contractor comes in more intimate contact than any other practitioner in the field of electrical science. These problems include that exceedingly numerous

class of cases in which the present illuminating results are either unsatisfactory in quality, inadequate in amount, or unreasonably low in efficiency. The wiring contractor in fact might properly give himself the degree of "Doctor of Illuminating Engineering," for he certainly is more often called upon to doctor up all forms and conditions of illuminating blunders and botch jobs than anyone else in the profession. When the user finally becomes aware that his case is so bad as to demand professional treatment, it is the electrical contractor to whom he most naturally turns for assistance. What he wants is a practical diagnosis of the case, and a remedy prescribed by the dictates of common sense based upon a good deal of experience and as much theory as may be available. The usual cry is for more light; but what is really wanted is either more or better illumination, which can often be produced by the use of less actual light. The electrical contractor should at least, be able to supply this first aid to the injured.

On the other hand, the professional illuminating engineer must be familiar to a certain extent,—the more the better,—with the principles of electrical wiring, for two reasons; first, because, of two or more equally good plans of locating light sources, the one should naturally be chosen which affords the more practical system of wiring; and second, because in many small installations the illuminating and wiring problems may properly be worked out together.

As a goal for the ambitious wireman, therefore, illuminating engineering is certainly most attractive. The wiring contractor who is able to give his clients the most economical and satisfactory illuminating results will have the long end of the lever in meeting the competition of wiremen who can merely follow plans laid down by others, or string up additional lamps when the request for better illumination is presented to them.

Auditing Lighting Bills

There are at least two concerns in this country that, in connection with a general illuminating engineering practice, make a specialty of auditing and adjusting disputed bills for lighting. The existence of these concerns naturally leads to the question, "Why should there be such disputed bills, as to afford profitable occupation for professional adjusters?" Various answers may suggest themselves to this question. On first thought, the fact might be taken as a reflection upon the honesty of the lighting companies; but further consideration will show that this is by no means a logical conclusion. Generally speaking, a lighting company is no more and no less likely to deliberately set out to defraud its patrons than is any other corporation dealing with the public. Where such companies have had a monopoly, there have undoubtedly been many cases where they have taken an attitude toward their customers of being infallible in regard to the amounts of bills rendered, and have maintained this assumption of infallibility with needlessly irritating methods; but even this admission by no means justifies the assumption that they deliberately set about to give false measure.

The chief cause of disputed bills—which, by the way, are largely confined to those for electric-lighting—is undoubtedly to be found in the imperfections of the measuring apparatus itself. The electric meter is by no means a perfect instrument, and those who read Mr. Macbeth's articles on this subject, which appeared in our previous issues, will readily under-

stand how erroneous readings may be made by the most straightforward companies. Besides this uncertainty in the measuring apparatus itself, the units in which electric current is measured mean absolutely nothing to the average consumer; and the relation between the units of electricity and the amount of illumination received is so extremely indefinite that it is no wonder the consumer may go wide of the mark in attempting to judge of the correctness of his bills by the amount of light received.

Disputes over bills may, therefore, arise from instrumental errors, or from a misunderstanding on the part of the consumer, and both parties to the dispute be perfectly honest in their opinions. In such cases, the good offices of a disinterested party is the most natural and obvious agency of reconciling the differences, and bringing the dispute to an amicable conclusion without the costly, tedious, and irritating process of a resort to the courts. The consumer naturally looks with suspicion upon all overtures made by the company itself, on the assumption that it is seeking only its own advantage. The professional auditor, therefore, may fill the position of an arbitrator, who not only seeks to get at the exact facts as to the money differences, but also to point out how the discrepancy arose, and pave the way for the avoidance of future misunderstanding. The large majority of lighting companies at the present time are sincerely anxious to deal justly with their patrons, and in a great number of cases are endeavoring to go still further, and to assist their patrons in every way in securing the best possible illumination for the money expended. Our own representatives have during the past year come in personal contact with the management of a large number of lighting stations scattered from Maine to Colorado, and in making the above assertion we are not expressing a mere platitude, but are speaking "by the book." The auditor who is thoroughly competent through his knowledge of the technology of these particular measurements, and of the methods of accounting, therefore not only occupies a perfectly legitimate position in the lighting field, but should be accepted by both consumer and producer as a "friend in need" in maintaining that *entente cordial,* which should always exist.

Illuminating Engineering in Great Britain

Illuminating engineering may fairly be said to have become an established branch of applied science in this country about a year ago. The formation of the Illuminating Engineering Society, and the appearance of THE ILLUMINATING ENGINEER may be taken as the public evidences of this fact. While public recognition of this newest of the special branches of engineering has thus been first accomplished in this country, it must not be inferred that the study and development of the underlying principles of the subject likewise originated with us. It would no doubt surprise the American student of the subject to find how much of the matter which is apparently new was worked out and published in England ten or twenty years ago.

Among the English engineers, Mr. Leon Gaster has undoubtedly taken a livelier interest, and has done more aggressive work in the endeavor to establish illuminating engineering as a profession in England than any of his comperes. We are, therefore, particularly pleased to be able to present an excellent portrait of Mr. Gaster in this issue.

From Our London Correspondent

We are sure that all the illuminating engineers in America will be grieved to hear that William Sugg passed away on the 28th of February at the advanced age of seventy-five years. It was a privilege to have enjoyed his friendship for many years, and like hosts of others, we had a great regard and affection for him. He was a born experimentalist, and was the pioneer illuminating engineer in this country. Almost within a week of his death he was in harness, engaged upon the improvement and advancement of high pressure gas lighting. One of the finest examples of street lighting in Great Britain, if not in the world, is to be found in Whitehall and Parliament streets, Westminster; the scheme was conceived and carried out by Mr. Sugg, and as a public illumination is the admiration of all. Financially it has proved a marked success. William Sugg was an Associate Member of the Institution of Civil Engineers, and a short time back the members of the Institution of Gas Engineers conferred upon him the distinction of honorary membership. He was in truth one of the shining lights of the nineteenth century; his life was a long and busy one; he has now "crossed the bar," and entered into everlasting rest.

Under the "Sale of Gas" Act of 1859, it was provided that: "No meter should be stamped which should be found to register quantities varying from the true standard measure of gas more than two per centum in favor of the seller, or three per centum in favor of the consumer." This has been the law of the land for forty-eight years. It has often been thought that it should be possible to accurately measure the quantity of gas consumed, and efforts have been made from time to time, but so far no change in legislation has taken place. The Institution of Gas Engineers have, through their Parliamentary Committee, called the attention of members and others to a report presented by a Committee of the London County Council, which in the form of a Recommendation suggests to the Board of Trade an amendment of the Sales of Gas Act of 1859 in several important particulars. All gas meters manufactured have to pass the tests prescribed by the act, the power being vested in the municipality; that authority, in the Metropolis, is the London County Council; and as in every other brand of office work undertaken by them, they have spent large sums of money in the establishment of Meter Testing Stations. The report referred to says: "Having regard to the extensive use of gas for heating and power purposes, we consider the time has arrived when some further attempt should be made to remedy the present unsatisfactory state of affairs." They then set forth the principal defects in the before

mentioned act. Of these the principal one, that attention is called to is, that no provision is made for testing the indices of meters, where the largest amount of error is likely to arise. This is perfectly true; many of these indices, which are only a train of wheels, are carelessly made, and are neither scientific nor correct recorders of measurement. The suggestions for remedying defects are particularly: The reduction of the range of error permitted in meters to one per centum. The power for a consumer to have a meter tested whether it be stamped or not. Provision for testing *in situ*, and for testing the index. The periodical re-verification of meters.

There is no question that gas meters do not register correctly; but looking back upon a long experience we venture to say that by far the greater number of meters that are incorrect are in favor of the consumer rather than the seller. This is due to carelessness on behalf of the supplier. In small country towns it is no uncommon thing for gas meters to remain undisturbed for periods of 10, 15, and even 20 years. If these meters were running fast the consumer would be extremely anxious to change them, and we venture to say that should they be taken out it would be found that as old age had crept on, the registration became slow and feeble, very like men and women getting old.

The city of Liverpool is supplied with gas by a company, but the illumination of the streets is controlled by the municipality, who have a superintendent, who is taking a very active interest in the improvement of street lamps, and has recently designed a lantern for a single incandescent burner. The accompanying illustration, Fig. 1, gives a good idea of the appearance of the lamp, and also shows its construction. In Liverpool

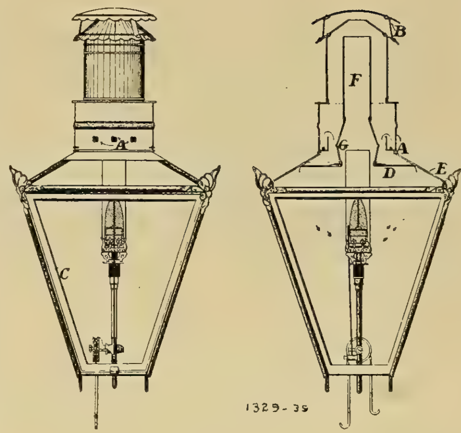


FIG. 1.

difficulties have been met with in connection with the deposit of naphthalene, and it is hoped that the use of this special lamp will, to a considerable extent, remove the obstructions. A reference to Figure 1 will show that the air enters the lamp by the inlet *A*, the ventilating top is shown at *B*, the cleaning door, *C*, the lamp has an enameled sheet reflector, *D*, over which the supply of air is obtained for the burner. *E* is an opal reflector, *F* shows a tube which serves to increase the draught, and *G* is the expansion chamber.

The need of technical knowledge in our law courts is frequently discussed; this is particularly noticeable among the leading counsel and barristers. It is, of course, difficult for the legal mind to grasp the technicalities of arts, science and manufacture. Arguments as conducted in the courts of law upon engineering cases, for example, are often grotesquely wide of the mark. Quite recently a gas engineer, Mr. Chas. E. Brackenbury, who was apprenticed — went through "the shops," as we say was afterwards articled to a consulting gas gas and water engineer, and in due course placed in charge of the erection of works, becoming at last resident

engineer and manager of an important gas undertaking abroad; recently gave up his position, became a student of the Middle Temple, and has been duly called to the Bar. He intends to utilize his special engineering knowledge, and we doubt not that in a very short time his services will be in considerable request on gas and water bills before Parliament, in arbitrations connected with the sale and acquisition of gas undertakings by municipal authorities, appeals against assessment for rates, patent cases, etc. His practical experience and expert knowledge as an engineer will be of great service to those who retain him as counsel.

We have before us the third edition of "The Gas Engineer's Pocket-Book," edited by Mr. Henry O'Connor. This book has just been published and brought up-to-date. It is a useful book to have at hand and there is much in it of great value to the illuminating engineer. It is not our province to review books for this magazine, but we can safely advise those who desire to possess a handy work of reference to add this book to their technical library. The notes that we are giving upon the work of the Metropolitan Gas Reference has been prompted by a perusal of Mr. O'Connor's Pocket-Book.

No doubt some of the readers of THE ILLUMINATING ENGINEER will be aware that in August, 1906, the Gas Referees, the governing, or official body who control the legislation having reference to the quality of gas in London, issued a "Notification," which included instructions as to the illuminating power of gas and the method of testing the same; and it will not be uninteresting to illuminating engineers to give a short summary of this "notification." We shall only refer to two sections. First, as to the standard lamp to be used for testing the illuminating power. The standard lamp is the Pentane 10 candle-power lamp, which must be examined and certified by the Gas Referees. This lamp is one in which air is saturated with pentane vapor, the air-gas so formed descending by its own gravity to a steatite ring burner. The flame is drawn into a definite form, and the top of it is hidden from view by a long brass chimney above the burner. The chimney is surrounded by a larger

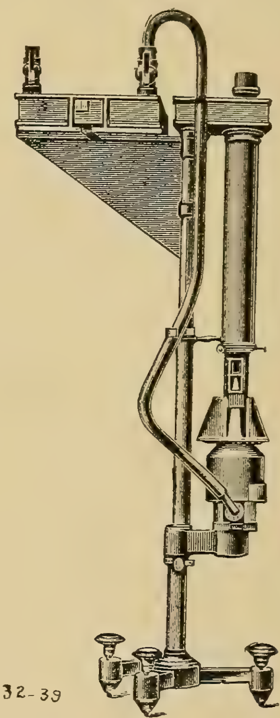


FIG. 2.

brass tube, in which the air is warmed by the chimney, and so tends to rise. This induces a current which, descending through another tube, supplies air to the center of the steatite ring. No glass chimney is required, and no external means have to be employed to drive the pentane vapor through the burner. The illustration, Fig. 2, shows the general appearance of the lamp. The cost is £10 10s. ($50.40);

or one more elaborately fitted up and specially tested by the Secretary of the London Gas Referees may be purchased for £20 ($96.00).

The pentane used in these lamps is prepared in the following manner: Light American petroleum is further rectified by three distillations at 55°, 50°, and 45° C. in succession. The last distillate is to be shaken up from time to time during two periods of not less than three hours each with one-tenth its bulk of (1) strong sulphuric acid, (2) solution of caustic soda. After these treatments it is to be again distilled, and that portion is to be collected for use which goes over between the temperatures of 25° and 40°.

This distillate will consist chiefly of pentane, together with small quantities of lower and higher hamoloques whose presence does not affect the light of the lamp. Pentane ($C_5 H_{12}$), is manufactured in accordance with the "instructions" we have briefly set out, and retails at £1 2s. ($5.28) per gallon.

We have particularly called attention to the Referees' instructions, because a new burner has been determined upon for testing gas in London, known as "The Metropolitan Argand Burner, No. 2." Its compulsory use came into force on the first of January last year; we gave a brief description in the London letter published on page 258, No. 4, Vol. I, of The Illuminating Engineer. The instructions provide that this burner shall be the standard burner, and that "no argand burner shall be used for testing the gas that does not bear the lead seal of the Gas Referees." A clean chimney is to be placed on the burner before each testing, and care should be taken that the glass does not become dimmed by the smoking of the flame. The gas under examination is to be kept burning at about the usual rate for at least fifteen minutes before any testing is made. No gas shall pass through the meter attached to the photometer except that which is consumed in testing, or during the intervals between the testing made on any day, and that which may be used in proving the meter. The paper used in the screen of the photometer shall be white in color; it shall be as translucent as is possible consistently with its being sufficiently opaque to prevent any change in the apparent relative brightness of the two portions of the illuminated surface when the head is moved to either side.

The testings are to be made in the following manner: The index of the regulating tap shall be so adjusted that the meter hand makes one complete revolution in not less than 59 or more than 61 seconds. The damper for regulating the air supply to the burner shall be screwed upwards until the flame is on the point of tailing above the chimney and then immediately be turned down only so far as to ensure that the flame burns, and without any smoking. The connecting rod is now pushed to and fro by the gas examiner until the illumination of the screen by the two sources of light is judged to be equal. A balance is best attained by alternations of decreasing amplitude rather than by very slow movements in one direction only. The reading of the photometric scale must be noted, which observation has to be made four times in all, and the mean taken. Note must be made of the time the meter hand takes to make exactly two revolutions, which is done by the aid of a stop watch. The mean of the four readings of the photometric scale has to be multiplied by the number of seconds recorded and by the ærorthometer reading then divided by 120, which gives the illuminating power.

We give an illustration (Fig. 3), of Carpenter's Metropolitan Argand Burner No. 2; there is very little doubt that this burner will ere long, be used universally in Great Britain. The air supply is made adjustable to the type of gas being burned. It is the only burner which approaches perfect combustion of any kind of gas, whether pure coal gas, enriched coal gas, or coal gas mixed with carburetted water gas.

The appropriating of this burner by the Metropolitan Gas Referees has given much satisfaction, for although the No. 1 London Argand Burner, the invention of the late Wm. Sugg, has been in use for close upon forty years,

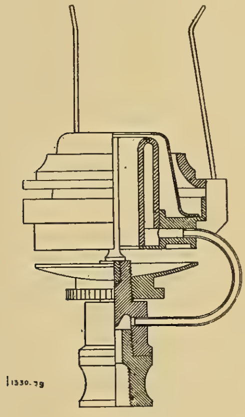
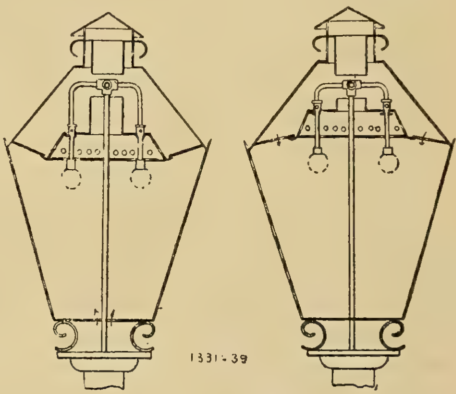


FIG. 3.

it has not for many years been considered a satisfactory testing burner for gas as now made and consumed.

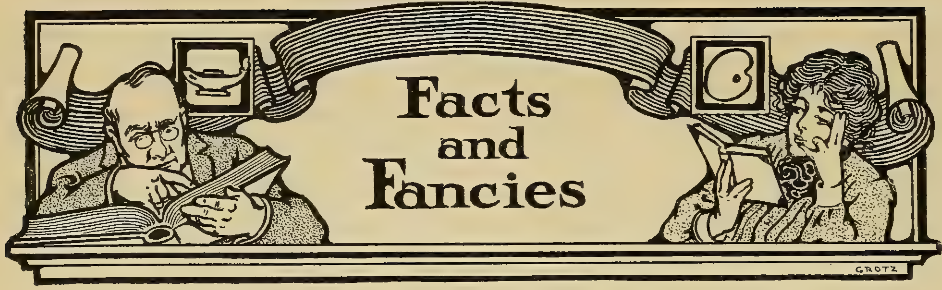
An inventor in Berlin has produced another street lamp specially for the use of incandescent burners. His methods of fitting up may, we understand, be easily adapted to existing street lanterns. The illustration in Fig. 4 shows a lamp in which the air supply is drawn partly from the bottom, while in Fig. 5 the air supply is drawn entirely from the top. At about the height of the usual reflector a sleeve-like casing is fitted, through which the inverted burners are passed and connected to the gas supply pipe; at the bottom this casing is closed by a plate that offers a support for the reflector which bears loosely upon it. The inverted burners are so fitted that the air-supply nozzles are outside the casing, whereas the burner-heads and incandescent bodies pass through comparatively wide apertures in the bottom plate. A partial air supply takes place from below the chamber formed, on the one hand by the cover of the lamp roof, and on the other hand by the reflector and casing. The products of combustion are compelled to ascend through the apertures in the bot-



FIGS. 4 AND 5.

tom plate, and pass out through the central pipe to the lamp ventilator. If, however, the air is supplied only from above the reflector is provided with a series of apertures through which external air is drawn into the lamp when the burners are ignited and, as a consequence, an upward current of combustion-gases is set up. It will be seen, therefore, that in both the circumstances described the incoming air supply to the burner is not contaminated with the products of combustion.

CHAS. W. HASTINGS.



Centenary of Public Lighting by Gas in England

A leading daily newspaper, in its issue dated 29th January, directs attention to the interesting fact that exactly 100 years previously large crowds assembled in Pall Mall (a fashionable West End thoroughfare) to gaze at a row of gas lamps which a certain German, named Winsor, had set up in front of the colonnade before Carlton House in honor of George III.'s birthday, and which were practically the first gas lamps seen in the streets of London, although Murdoch had demonstrated the practicability of coal gas some years before. As usual with new departures from the established track, there were scoffers, ignorant and otherwise. Some held that it was a perversion of the ways of Providence that could not fail to bring its own punishment on all who made and all who used the new illuminant. Even so great an authority as Sir Humphrey Davy, the leading scientist of the day, declared that it would be as easy to bring down a bit of the moon as to light London with gas, and asked if the dome of St. Paul's was to be utilized as a gasometer, thus setting off a lead that hampered the progress of the gas industry for many years. Some of the smaller fry in the scientific world proved conclusively that there could not be a light without a wick. Having sketched out the position in 1807, attention is directed to the condition of London streets in 1907 during the hours of darkness and the share taken therein by gas. The scientists of the former period were clever in their way, but poor prophets, for it is gas that has enabled the results so highly eulogized to be secured, and the wick has been relegated to quite a back seat in the matter of artificial lighting. The desire for efficient street lighting, the advantages of which are eloquently set forth in the paragraph under review, is of comparatively recent growth. It was not till the introduction of the incandescent gas burner that a reliable means of flooding our public streets with light at a reasonable cost was available. Previous to that period economy as regarded the public rates was the chief consideration. The principal thoroughfares were indifferently lighted, the back lanes and alleys not at all, and a reduction in the already meager light at midnight was the general custom. About 10 years ago the writer was concerned in the installation of 100-candle incandescent burners in place of 15-candle flat flames, throughout a city, and on the first night of the change happened to meet the chief officer of police. The officer spoke very highly of the alteration on the ground that it would enable his men to recognize any suspected character, and foretold a great decrease of crime, because of the difficulty thus thrown in the way of escaping undetected. The same officer, by the way, was instrumental in opposing a scheme for reducing the lighting at midnight. The views thus expressed in 1897 have become the voice of the public in 1907, and it is recognized that efficient public lighting is indispensable in any town that wishes to keep up with the times.—Norton H. Humphreys in *American Gas Light Journal.*

Gas Lighting Eighty Years Ago

It is now eighty years since gas was introduced into Berlin. On September 14, 1826, the Unter den Linden appeared for the first time under what was then called the blinding light of the gas burners of the period. Hanover and Hamburg had preceded Berlin, and Dresden followed in 1828. Curiously, in Dresden they made so much of the new illuminant that they made all arrangements and then waited until an heir to the throne should be born. When he—afterwards King Albert of Saxony—drew breath, the gas was lit and the streets illuminated amid great rejoicing.

Street lighting was, however, opposed at the time on theological grounds, as being a presumptuous thwarting of the intentions of Providence, which had appointed darkness for the hours of night; on the ground of objections to taxation in any form; on medical grounds, gas and oil being unwholesome and it being a bad thing to encourage people to wander about after dark and catch cold; on moral philosophic grounds, people's ethical standard of conduct being lowered by gas lighting in the streets, for the drunkard would feel there was no hurry to go home, and late sweethearting would be encouraged, whereas black darkness sent people home early and thus preserved them from a multitude of sins, on police grounds, as the lighting would make horses shy and thieves alert; on political economy grounds, having in view the money which would have to go out of the country for coal and oil; and on the patriotic ground that national illuminations would lose their stimulating effect if there was a quasi-illumination every night of the week, year in and year out.—*The Gas World.*

Lights of the Stage

In no place in the world, unless it is a coal mine, is lighting of as much importance as it is on the stage. The success or the failure of a production in these days may actually be decided by the skill of the men behind the scenes in managing the lights.

Away back in the days of the ancient Greek drama, as even now in the production of the wonderful Passion Play at Oberammergau, the lighting was that of nature, and the stage was in the midst of a huge amphitheater, lighted by the sun, when the sun shone. Otherwise the actors stoically played on with rain dripping off their hair and garments—but they did not have realistic furnishings and velvet and lace robes and marvelous scenery in those days!

The Elizabethan actor was scarcely better off, for plays were often given then in the courtyard of an inn. Few of the theater-lovers of our day know that the modern stage is really descended directly from this medieval setting. Where the sixteenth-century actor paced the stage surrounded on three sides by the auditorium, we have one which juts out but slightly into the audience-room; where the guests of the inn sat at the windows of their rooms, invaded the wings, or grouped themselves in balconies, we have boxes in two or three tiers on each side of the stage; and where the common folk sat on rude benches, or stood for hours in the courtyard, we have our parquet, or what the English call the pit of the house. Above all, where the Elizabethan actor had torches, or guttering candles, or the light of day, we have a brilliantly illuminated stage. Much of the unreality and inartistic absurdity of unskilful stage effects are due to the footlights, which are a legacy from that transition period when the theater became a roofed-in building and had to be lighted with the inadequate means then available. At one time the footlights were candles set—probably for safety's sake—on tiny rafts in a trough of water; then kerosene lamps did duty; but from the time plays began to be generally acted in a hall, every bit of light possible had to be cast upon the stage to make the drama intelligible to people in every part of the house. For acting differs from every other art in this —that its slightest and subtlest effects must appeal alike to those close at hand and those at a great distance, for upon a most delicate change of expression the meaning of a whole act, or a telling speech, or the development of a plot may depend.

The presence of footlights, however, makes the art of stage lighting one of infinite difficulty. Making up the face so that it will appear natural in a light which comes partly from below is a business by itself. Anyone can easily see how this must be so, by trying the simple experiment of holding a candle below the face and looking in the glass. The lower jaw and cheek are grotesquely exaggerated and the forehead minimized, while the natural shadows of the eyebrows are quite lost. The time may come when improvements in the art of lighting will make it possible to light a stage in the natural way.

Coloring, too, is affected by the artificial character of a stage-light. A scene must be painted, a costume selected, for its qualities by artificial light. The ramifications of the science of costuming and of scene-painting are endless. But the present passion for realism must eventually lead to a scheme of lighting as near the natural as possible. It became obvious in the country plays so popular several years ago that you cannot bring on the stage a load of real hay, a quantity of genuine pumpkins, or any other striking work of nature, without making the artificial stage properties look theatrical and flimsy, whereas if all

the stage setting is make-believe the illusion is preserved—after a fashion. The perfect light for the stage will eventually be that which allows the stage artist to come as near to nature as possible in his color schemes. The success of plays which have been given in the open air, as in a California theater, in the grounds of some of the colleges and in recent reproductions of the Elizabethan drama, proves that exquisite scenic effects are more easily attained when nature can be made to cooperate with art.

The middle of the nineteenth century was the era of the artificial, and the stage was as artificial as all the rest of it. Now we seem to be drifting gently in the other direction. Eventually stage lighting may reach such a point of perfection that all the color secrets of nature will be at the command of the scenic artist. As it is, the lighting of private grounds and gardens artificially has enabled amateurs to do effective things with out-of-door theatricals by night, and some enterprising manager may one of these days work up a plan for larger dramatic undertakings along this line, to be carried out by professional dramatists and actors, scene-painters and costumers. There is literally no knowing what the mechanical ability of the world may achieve in the assistance of art during the next half-century.—*Gas Logic.*

Electric Gas Lighters

In my house in New Jersey we use gas for lighting and have also a large gas range for cooking, in addition to a coal range and a 3-hole gas plate for boiling clothes in the laundry. When the gas range was put in, an intelligent agent of the gas company hung beside it a card which displayed in large type this chunk of real wisdom: "MATCHES ARE CHEAPER THAN GAS." Following the guidance of this motto and having in the family several men who smoke, resulted in a pest of match sticks, we found them lying around everywhere.

To overcome this difficulty and to save the trouble of hunting for matches, I have recently installed a sparking outfit and fitted up a considerable number of my burners with electric lighting attachments. These have proved not only effective in getting rid of a large part of the pest of match sticks, but their convenience of operation is so great that each member of the household is clamoring for similar attachments in other parts of the house.

The outfit is very simple and once introduced the cost and trouble of maintenance are insignificant. The main outfit consists of a sparking coil costing $1.50 and 2 dry cells, costing 30 cents each. One side of the battery is connected by wire to the gas pipe system. The other side is wired to the lighting attachments at the burners. There is a bell system in the house; the wires from one side of this can be used for the sparking circuit without interfering in any way with the bell circuits. I use one of the bell wires in my house for taking the sparking current to the 2d and 3d floors.

The first place where I installed an electric lighting burner was in the warm side of my cellar, beside the heating furnace. Next, I put one in the cold side of the cellar where light is needed at frequent intervals for getting food or putting it away after meals. These are both on fishtail open burners. Next, I put an electric lighter on a Welsbach burner in the kitchen. Since then I have installed lighters in the bath-room and at various places where it is desirable to be able to light the gas readily for temporary use. My greatest stunt, however, was in making an electric torch for lighting the gas range and the wall lights near the range. This torch is something like those in the market which have the cells and sparking coil in their handles, except that it gets its current from the gas pipe and wiring system. It is connected by flexible conductor cord and hung by this over the gas range with pulleys and a small counter-weight, so as to keep it out of the way and yet make it handy to use. I think it would pay someone to put a torch like this on the market. I am now arranging another lighter at the end of a drop-light rubber tube for the use of myself and the other smokers of the family. A handy device of this sort ought to make a good seller in the market.

Such devices not only promote the comfort of the family and tend toward neatness and economy, but increase the use and consumption of gas in a legitimate way by adding to its usefulness. With the electric lighters, gas becomes as handy as electricity and lights can be as readily turned on.—F. F. COLEMAN in *Progressive Age.*

Close to the People

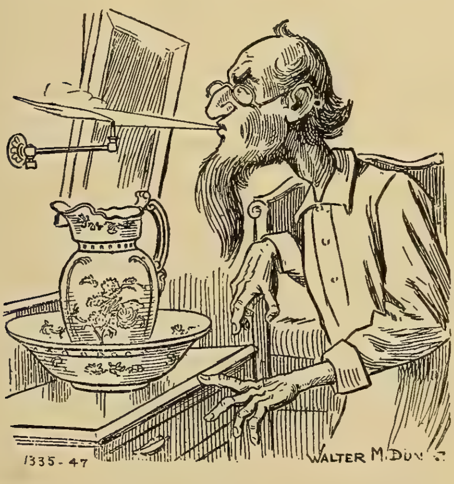
A Bas Kilowatts!—By way of illustrating the rapid increase in the wealth of the country the *Leavenworth Times* announces that the Kansas City Western Electric Railway has 1,700 kilowatts, which is exactly 400 kilowatts more than it had when the power house burned. It is these things that cause social unrest. Here is a bloated corporation strutting around with 1,700 kilowatts, and thousands of poor people haven't a kilowatt to their name.—*Kansas City Journal.*

The Candle Nut

The candle nut is a native of the Pacific islands, and the name is derived from the fact that the kernels are so full of oil that when dried they can be stuck on reeds and used as candles. The people of Hawaii after having roasted these nuts and removed the shells reduce the kernels to a paste, which when flavored with pepper and salt is said to be a most appetizing dish. The husk of the nut and the gum which exudes from the tree have medicinal values, while the burned shell is used to make an indelible ink with which tattooing is done.

And the Blow Almost Killed Father

A correspondent in Chicago incloses the following sketch which is self-explanatory.



The sender also suggested that "father's" blow was so strong, if continued it could not fail to be exhaustive."—*American Gas Light Journal.*

Seeing by Electricity

Almost at the same time two different inventors in different places have announced their success with electrical devices for seeing at a distance. They are J. B. Fowler and William H. Thompson. In Fowler's device four wires are required to accomplish the combined effect of distant vision and hearing. Details of the operation are withheld, however, on the plea of getting out a patent. Each inventor has adopted the name of "televue."

Ripening Bananas by Electric Light

An English electrical expert has discovered a means of ripening bananas to order. The bunches are hung in an air-tight glass case in which are a number of electric lights. The artificial light and heat hasten the ripening process in proportion to the number of lights turned on. Records have been made which enable the operators to make delivery of any desired quantities at any agreed date.—*Popular Mechanics.*

Defective Vision of School Children

It seems easier to point out the presence of defective vision in the young than its remedy. In a school census in New York completed March 14th it was shown that there are 688,427 children attending schools in Greater New York, and the startling thing about the report is the statement that out of 58,948 children whose eyes were tested, 17,928 were suffering from defective vision. Dr. Maxwell, head of the school board, recommends that the city supply glasses to poor children who cannot afford to purchase them.

A Novel Gas Mantle

M. Emile Louis André has put forth a curious idea, and, what is more, he has patented it in France. He uses an egg-shell, literally an egg-shell, as an incandescent mantle, for acetylene flames. It does not shatter or break, he says, and it gives a pleasant soft light. All the preparation that is needful is to make a hole at each end of the shell, and to put the shell in position with the burner inside. The burner head throws out lateral flames which impinge on the interior of the egg-shell.

Illuminating Engineering Society

I·E·S

GROTZ 1907

Meeting of the Chicago Section, January 17th

Topical Discussion of the Following Subjects:

1—*Large versus Small Units in Street Lighting.*

2—*Globes and Reflectors for Street Lamps.*

3—*New Street Lamps.*

Albert Scheible.—The question of large versus small units is interwoven with that of the permissible spacing and locating of the lamp, and the latter in turn will vary with the purposes to be accomplished by our street lighting. If street lighting had always only a single aim, the problem would be simpler, but conceptions of it differ, and practice must vary accordingly. For instance, twelve years ago at one of the Northwestern Light Association's discussions, a Wisconsin member admitted turning the incandescent lamp brackets in his town over the sidewalks instead of the streets. He did this because his fellow-citizens tramped on the sidewalks, while those driving out with their best girls were content without any light on the subject. In either case the lighting would have meant path-finding, which is one of the great aims of all street lighting.

The other aim, to which too little attention has been paid, is crime-prevention. For this purpose there are three requirements; the first is the absence of strong contrasts. These are found whenever the lamps are spaced so far apart that their rays do not appreciably overlap, so that consequently there results a strong shadow contrasting with the light on the street nearer the lamp. Second, the prevention of crime by street lighting cannot be complete unless the alley entrances are lit also. Placing a lamp at the mouth of each alley may swell the number of lamps and complicate the lighting problem, but the lighting is largely for the safety of pedestrians, and how are we going to get rid of those danger points unless the mouth of each alley is properly lit? How is this to be done without small units at those entrances?

Another phase of the problem of crime-prevention by street lighting requires that street illumination should not be judged merely on the level of the ground. If a man approaches after dark, one does not care what his feet are like; it is his face that should be seen, and what he has in his hand. The curves given for present street lighting and the heights of lamps all seem to have been based on getting the illumination on the level of the street. The lighting that would enable one to see at a height of three or four feet above the ground would usually be ample at the feet for path-finding. This point certainly does not seem to have been considered by those who reduced the height of their alternating arc lamps to fifteen or sixteen feet above the ground. Of course, an effective illumination on a higher plane than the ground means a further effort towards horizontal rays of light, and unfortunately it is not practical to resort to prismatic reflectors because of their expense and the frequent breakage. The ideal light distribution curve figured out by Dr. Hugo Rouess, of Hamburg, resembles closely the shape of the blades of a vertical fan motor. It contrasts strongly with the acorn shaped curve of the flaming arc lamp. The nearer the bat's wing type of curve is approached, the more efficient will be the distribution of the light from any given unit.

W. D'A. Ryan.—The question of large *versus* small units resolves itself into a question of local conditions and application. There are certain streets, suburban streets, and alleys where incandescent lighting does very well. There are other streets where a high power arc is desirable. In a paper read some time ago on relative merits of open and enclosed arcs for street illumination, I pointed out the value of what might be called a small unit in arc lighting. This lamp consumed 4.4 amperes, giving four amperes at the arc. The purpose of this lamp was for installation in suburbs, where there is a great deal of foliage and it is not possible to place the arc lamp up from 25 to 30 feet. For a given wattage per mile, leaving out the question of the necessity of placing the lamps midway between blocks and on corners, which, of course, must be considered, there would be eleven 7.5 ampere lamps consuming 485 watts per mile with a minimum illumination of .03 candle feet, as against eighteen of the 4.4 ampere lamps, giving eleven points of maximum illumination against eighteen points of minimum.

It is a great mistake to take an ordinary lamp with four amperes, because there will be only 3.6 amperes at the lamp. If I am not mistaken, they are running lamps of that kind in Cincinnati, but they missed the mark by putting four amperes on the line instead of in the arc. Furthermore, such a lamp is not fit for illumination for the main streets in the central part of the city. It is not only a question of candle-power and distribution; it is a question of effect. A much better effect may be got where the buildings are high by a large luminous surface. The object is seen on the dark background. For certain classes of lighting, to get the best effect a large unit is necessary. The intermediate arc unit of course has not become generally used, but it certainly would be an excellent lamp for the suburbs.

As for distribution, all are no doubt familiar with the characteristic distribution of a direct current arc. The light varies from side to side. That is to say, when the arc is on one side of the carbon, giving an illumination in one case here of probably 600 candles at 25 degrees below the horizontal, on the opposite side there are only 200 candles at the same angle. That is one great defect of even the enclosed arc.

The latest lamp for street lighting in this country is known as the magnetic type. It is a lamp of the flaming arc class; more properly a luminous arc rather than a flaming arc. The flaming arc has a downward characteristic, and is not desirable for street lighting. What is wanted is something on the bat's wing order, as just shown by Mr. Scheible. The magnetic lamp has a characteristic very similar to that. The lamp takes 325 watts, nas a maximum lighting distance in the illuminometer of 309 feet five feet above the street. The direct current arc lamp has a lighting distance of 255 feet at the same level. There are different ways of making this comparison. We may speak of linear feet per watt, which is very useful when the lighting is straight up and down the street, or if when lighting the center of a square it is useful to compare the square feet per watt. Comparing these two lamps in linear feet, we have in one case one-half foot per watt and in the other .95, practically double. Squaring this, to give illuminated area, gives 254 square feet for one as against 588 for the other. The lamp is somewhat more efficient than a direct current arc, but its principal value is in the fact that it has fine distribution with the maximum at ten degrees below the horizontal.

For incandescent street lighting, a lamp of 50 candle-power should be the minimum for all suburban streets, particularly in a town or city of any size. The 24 and 32 candle-power lamps are too small. Further than this, we should use a reflector which has some value as a distributor of light rather than a water shed. We get practically nothing out of the reflectors we have been using for years, yet it is not at all difficult to increase the effective illumination 35 to 40 per cent. by means of a reflector.

Frank McMaster.—My experience in street lighting has shown that the tendency in nearly all the better lighted cities is to the smaller units. Mr. Ryan's remarks indicate that, and the practical work of a great many of the better cities is tending to the smaller units. Reliable measurements, taken for street purposes, are very rare, and when the whole thing is simmered down, it is not a matter of candle feet or candle-power, but is the actual effect, it is a question of seeing where we are going, what the other fellow is doing, and how well we can recognize people on the street. To do this with large units produces an effect on the eye which contracts the pupil, and as the effective light for

seeing objects is practically entirely from reflection, where high candle-power units are used, the pupil is so closed up that we do not take in enough of this reflected light to see distinctly and the street appears badly lighted for that reason, although the candle-power-feet delivered to the street, or four or five feet above the street, may be very high; whereas, if a larger number of small units be used there is a more uniform distribution of the light, the pupil is not so contracted and we are able to see better. This effect has far more to do, or is more important, in the matter of street lighting than the actual candle feet delivered to the street or the angle at which it strikes the street.

The tendency to use smaller units is illustrated by a number of the larger cities which are making an effort to get better lighting in the business sections. A few are doing it with arc lamps, but a large majority are doing it with smaller units. I thoroughly agree with Mr. Ryan that 50 candle-power is as low a unit as should be used for outdoor illumination, and I further agree with him that the incandescent lamp, particularly in the smallest units, is not a lamp for outdoors, first, on account of its color, which is yellow-red, and gives a very poor reflection from green or brown or gray, the ruling colors outdoors, and for the other reason that the incandescent lamp in the smaller units is simply too small for the dark.

R. W. Bingham.—Taking up the first subject, "Large *versus* Small Units in Street Lighting," I would say that the basic principle of the Welsbach gas system is the small unit, that is, a standard unit of 60 candle-power. These are placed in the smaller towns, one at each street intersection, where the average block is about 300 feet long, arranged diagonally down the street. This 60 candle-power gas lamp will light very satisfactory 200 to 250 feet. In the larger cities, such as New York, Philadelphia and St. Louis, they place the lamps closer together, having as many as six to the block in some places. The locating of gas lamps or any lamps smaller than the arc depends a great deal upon local conditions, and especially upon the amount of money available for street lighting purposes.

Another advantage of gas mantle street lighting over incandescent electric street lighting is that a mantle street lamp throws most of its light in a horizontal direction, whereas an incandescent electric light, especially the Nernst, throws its best light downward or towards the ground immediately under it. The gas street lamps are placed about ten feet high, and as all trees should be trimmed at least twelve feet high, the foliage does not interfere with the distribution from them. Foliage gives much trouble when lighting with arc lamps. For the same cost, a much better distribution of light is obtained by using gas mantle burners than is possible with arc lamps.

When the gas mantle was first introduced for street lighting, a lamp with a deflector in the top was used. This has since been discarded and no deflectors or reflectors of any kind are used, for the reason that a mantle light seems to scatter in all directions, with the horizontal rays the strongest, the ideal method for street lighting.

In several instances, where more light is wanted at a certain spot, or the street must be better lighted than is possible with one lamp to the block 300 feet long, two or even three mantles are placed on a post. This not only gives much better lighting, but is ornamental. This system avoids the unsightly poles and wires, which are particularly objectionable in the residence district. The larger cities of the United States, as well as Continental Europe, are using the mantle system for street lighting. There are to-day in the City of New York about 40,000 gas street lamps. These are in the residence districts, 1,000 being in Central Park. There are in Boston about 12,000 gas street lamps, in St. Louis 18,000, in San Francisco 6,000 before the earthquake. Nearly every large city in the United States is using a great many thousand of these mantle lamps, because they found it was impossible to light that territory evenly with any form of electricity, and also possibly, in some instances, because they found it was more economical.

Mr. McMaster.—I happen to have a copy made from the 1906 report of the Department of Electricity of Chicago, giving the cost of operation for arc lamps, seven amperes, 4,000 hours; the mantle lamp, 3½ foot burners, 3,786 hours, rated at 60 candle-power; an open flame lamp rated at 20 candle-power, for 3,786 hours; and a gasoline mantle lamp of 60 candle-power. The figures are as follows:

Arc lamps, 505 watts at the bus bars, price per year	$52.63
Mantle lamps, including all labor and material, gas at $1 a thousand, 3½ feet per hour, rated 60 candle-power	20.36

Open flame, including all labor and material, gas at $1 a thousand, 3 feet of gas per hour, rated 20 candle-power, 3,786 hours............ 16.11
Gasoline mantle lamps, 60 candle-power, by contract................ 25.80

A vertical glower Nernst lamp has been developed, giving a very different curve indeed, very closely approximating the curve shown by Mr. Scheible, which is practically the ideal curve for street lighting.

Mr. Daniels.—The discussion so far seems to me to be principally one-sided. Nearly everyone seems to be in favor of the smaller unit. Very likely it is good practice in many cases. There are places, though, where the large units are more advantageous. In the underground system for street lighting, while the lamps cost, say, $20, the posts necessary to hang those lamps will cost $75 or $100, which makes the cost per lamp greater. The cost of the post, being the larger part of the investment, it follows that the larger unit that can be satisfactorily used per post the less the cost per unit of light. The appearance of the street in the daytime should also be considered. A lamppost is an ugly thing at best and the fewer that can be used the better.

F. W. Willcox.—The arc lamp, where conditions permit of its being used at frequent enough intervals, undoubtedly gives a greater volume of light and a better service than can be obtained, all things considered (investment, operating cost, etc.), from a smaller unit. Those conditions, however, are confined to relatively small portions of the large cities, and therefore affect relatively only a small percentage of the total lighting to be dealt with. It has always seemed to me that if it were practicable to produce an efficient satisfactory form of arc lamp of 200 candle-power instead of 400 candle-power, or 100 candle-power, there would be a strong tendency to distribute the lamp at more frequent intervals and not space them as is done today 1,000 feet apart and even greater distances, because of the restrictions of cost and other details. The race will be to that unit which will permit of the more satisfactory illumination. It is not a question of candle-power. It is not a question of anything else but actual illumination. Coming back to first principles, we all know the well-known rule that uniform illumination is always the most satisfactory illumination, because it permits of very low values with satisfactory results, where non-uniform requires very high values to give anywhere near satisfactory lighting. It is easy to surpass the large unit with the small unit with even lower candle-power by reason of the fact that by more frequent spacing of those units we can more evenly light the area and therefore more satisfactorily light it. A uniform lighting of one foot candle is far more desirable than even two or three foot candles with uneven lighting. There are instances in suburban districts where requirements could not be met by arc lamps because the arc lamps were placed far apart and the distances between were so poorly lighted that vehicles were constantly colliding with each other. They were replaced by incandescent lamps of much smaller candle-power, with the result that the illumination was even. With the improvements of to-day, which are coming very rapidly, these relative advantages are going to be accentuated decidedly in favor of the incandescent lamp. I do not mean to say that the arc lamp is to be relegated or abandoned. It has its place, as in the city of Chicago, in the business districts. There is nothing to match it where the city appropriations permit it to be placed close enough to give reasonably uniform illumination. We have the incandescent lamp at the present time of three, three and one-half and four watts per candle, which has shown better efficiency by uniform illumination than the arc.

There is another feature in connection with the matter, and that is the artistic effect. Judging from reports from certain cities in the country, there seems to be a tendency towards a change in the method of lighting. City authorities are anxious to have some artistic effect, some gala effect in lighting, particularly along the boulevards or main streets, to get away from the conventional lamp hung on a pole and suspended over the street. That demand can be better met by a smaller unit, which lends itself more readily to artistic effects than is possible for the large. Those are the elements that are going to give their influence very largely in favor of a smaller unit in street lighting, particularly as the larger part of the street lighting must necessarily be done by the smaller unit because of the limitation of cost and spacing apart and distance to be covered. Cities are growing largely in suburban area; there are larger districts to be lighted than ever before. There must be sufficient illumination for a man to be safe on the highway and at the same time it must not be illuminated too brilliantly. That can-

not be accomplished to the same advantage with the large unit as with the small.

Harold Almert.—A smaller arc lamp unit would be most desirable if the maintenance and the construction features would permit. The last occasion I had to install a street lighting system, one of the underground kind, was in Chicago about eight years ago, when Diversey avenue was illuminated for the Lincoln Park Commission. The Board that was in at that time looked more toward good illumination than first cost. At that time there was a diversity of opinion as to the type of street equipment to be used. The smaller unit was given no consideration, and it was only a question to decide at that time whether to use the series alternating current enclosed arc or the multiple or series direct current arcs. A careful report was made from the results given by twenty-five stations operating street lighting. The first cost of most of those systems which were all at that time overhead, showed an average cost of $150 per lamp. With an underground system, of course, this cost went up, and it mattered little what system was used, because the cost of underground cables and conduit and poles would be about the same for any and all of them. At that time the distribution curves that were available showed that the series enclosed direct current arc lamp gave the best curve and the best efficiency for street lighting. The small units were considered only to see what the relative cost would be, and, as I recollect, the ratio was about two to five as in favor of the large units. In order to get a uniform distribution, and in order to cut down the objectionable dazzling of the large units, the lamps were placed on each side of the street 250 feet apart, giving one lamp for every 125 feet, which, of course, is more than is permissible in average street lighting. This happened to be a boulevard and the cost was not so essential. The series direct enclosed lamp was adopted, with an opal inner globe and a clear outer, and a very beautiful effect was obtained. I do not know of any street or boulevard in the United States where the effect is so good. The dark spots in between lamps were almost entirely eliminated. Since then the operating man felt that he could get more light (and more light was all that he wanted—he either knew or cared little about quality), if he removed the opal inner globes and put on clear globes. The different effect is surprising. With the clear inner globes the traveling of the arc throws intense shadows.

In small communities and country towns the problem becomes more serious, especially as the councils in the smaller towns demand that the poles be put on the lot lines and extended out to the street corner. I cannot exactly see how the wiring scheme could be carried out for these smaller units close together on the streets, and the desired effect obtained. It is not a question of light only, as it is necessary to take in the question of construction. While the small unit may seem desirable on account of its lighting features, when it comes to the construction feature it is often questionable whether it can be adopted.

J. S. Allen.—I had occasion to close a contract within the last five or six weeks with our city. We installed an alternating current, multiple distribution system just as we have for private lighting. We distribute at 2,400 volts to transformers and use incandescent lamps almost entirely. We only have a few arc lamps right in the center of the town. We distribute about a mile and a half or two miles in either direction from the station and our cost has been very moderate. The city constructed its pole line, owns its lamps and everything, and buys its current from us. It owns the switchboard in the station. I know very little about the result in candle feet, but the lighting is very satisfactory. We use just an ordinary 32 candle-power lamp and have good hoods over them. They are placed one to a block, about 400 feet apart. In the downtown district there are a few arc lamps. The number of transformers is not large. By using No. 6 copper wire the small secondary current may be transmitted long distances, and the cost of the installation is small. There was an old-fashioned series direct current system before and the people were dissatisfied, but they are paying a larger bill now and are satisfied.

Mr. Almert.—I don't think a 32 candle-power lamp every 400 feet would be very satisfactory for most communities.

Mr. Allen.—We have a little country town and it is satisfactory, and I believe it would be satisfactory to any other country town like ours. In a town of 4,000 or 5,000 inhabitants the requirements are different from those in a city. But the sidewalks between these places are so you can see them. You can't recognize a person's face two or three hundred feet by a 32 candle-power lamp, but you can see to miss people and get along.

A. J. Marshall.—I heartily agree with Mr. Willcox. I think the subject of street lighting is one that should be given careful consideration. The first thing that I notice in street lights is something which I think will soon be almost a criminal offense, that is, having lamps bare, especially gas. In the use of incandescent electric lamps it is necessary to cut down the intrinsic brilliancy of the light by some form of artistic glassware. There is an installation in town I would like to call your attention to, that along the boulevard near the Auditorium Annex, where incandescent lamps are used placed in opal or ground glass globes in an upright position. They are doing there what a great many other people are doing, confining the light sources so that a great deal of the light never gets away from the units. For instance, in the case of gas lamps using two, three or four mantle burners it has been demonstrated conclusively that where four mantles are used the efficiency is 30 per cent. less than where four individual lamps are used.

In St. Paul a system of lighting has been installed along Sixth street, in which the lamps are placed in the opposite position to that in which they are used here along Michigan Boulevard; that is, placed in a vertical position. They there have used a number of smaller units inside of opaline globes. I am absolutely dead opposed to the use of several small units within a globe. If 50 or 100 candle-power is wanted, use one lamp, not several. Attention should be given to the style of glassware, not using the old familiar ground glass, which will slightly diffuse or cut down the intrinsic brilliancy of a light source, but is extremely inartistic in that at all times a ball of fire is visible through the glass. I prefer an opal, or rather a milk or porcelain shade, which completely hides the light source.

My work is given up principally to indoor effects, but I do prefer the small units, that is, 40, 50 or 75 candle-power lamps, placed on artistic posts (not the bunching of a half dozen small lamps on one post), and placing them in a graceful manner, endeavoring to get away from the shadow effects as much as possible.

J. R. Cravath.—This question of large *versus* small units simmers down principally to a question of the total amount of light to be expended on a given length of street. If a lot of light is to be distributed on a given length of street, it can be done with large units without producing a disastrous blinding effect. If, however, but a small amount of energy is to be spent on that length of street, large units far apart will produce a very serious blinding effect. That, of course, is independent of all considerations of shade trees and that kind of thing. You probably have all noticed that in the business streets, where there is a great amount of light coming from all directions, the ordinary arc lamp is not noticeably blinding; but in a residence street, where there is but one to every two blocks, one cannot see past it at all.

As to the relative distribution of light from gas or ordinary incandescent lamps, the ordinary electric incandescent lamp and the Welsbach burner give a very similar distribution; that is, the maximum candle-power is nearly horizontal, the principal difference being that the distribution from the Welsbach mantle burner is about what we get from an inverted incandescent lamp, as the lamp base shuts off light immediately underneath. This brings up naturally the question of reflectors for street lamps, which has not been touched on very extensively. The ordinary cheap reflectors used in incandescent lighting in residence streets at the present time are very inefficient things in getting light up and down the streets. They are simply water sheds and protectors. There is a large amount of light that goes above the horizontal that is not caught by the reflector.

Mr. Ryan.—I agree with Mr. Cravath that the characteristic distributions of the incandescent lamp as ordinarily employed for street lighting and the Welsbach are practically the same. The same statement is true of the vertical glower Nernst lamp, the glower Nernst flame. The maximum is practically on the horizontal.

The old open arc lamp gave double the light per watt given by the enclosed arc, but had a maximum intensity at 45 degrees below the horizontal, and had a very high intrinsic brilliancy. When approaching the lamp, within 50 feet everything was black beyond. The enclosed arc came out with somewhat better characteristics. Its maximum candle-power was carried up to 35 degrees. The magnetite arc has the characteristic of giving its maximum 10 degrees below the horizontal. The maximum brilliancy does not strike the eye except at very long distances from the lamp, so that one is practically 150 or 200 feet away before receiving it and the intrinsic brilliancy is not objectionable.

As far as the enclosed arc lamp is concerned, there is no question that the opal

inner globe is a better globe; and strange as it may seem, that it will increase the average lighting distance from 100 to 200 feet. This seems absurd; it is due to the shape of the globe, which becomes a secondary source of light at certain angles, which more than compensates for what is lost through absorption. The light has been redistributed and some of the light that was striking the ground near the lamp is thrown further away.

The Chair.—We would like to hear from Mr. Willcox on the subject of the tungsten lamp for street lighting.

Mr. Willcox.—The tungsten lamp has an efficiency of 1.25 watts per candle, the average lamp running about 1½ watts per candle under the average outdoor conditions. This lamp seems to lend itself particularly well to a street series system, because the systems generally use low voltage lamps running from ten to fifty volts per lamp, according to the amperage of the circuit, and therefore permit a metal filament lamp like the tungsten to be used to good advantage. A filament can be made, particularly for candle-powers above 50, sufficiently strong and heavy to be very durable. With filaments which give remarkably good light at an efficiency of 1¼ watts per candle, this lamp should effect a profound revolution in street series lighting, because it is a lamp which surpasses any illuminant we have to-day except the flaming arc. That type of lamp in street series lighting seems to have a great future.

Meeting of the Philadelphia Section, February 15th.

Incandescent Gas Lamps

By Thos. J. Litle, Jr.

The illuminating power of a gas flame is derived from the heating of solid particles into incandescence. The practice of gas illumination divides itself into two general principles:

First: Where the solid incandescent material is supplied by the decomposition of the gas in the process of combustion.

Second: Where the gas is completely consumed in a Bunsen burner for the production of the maximum amount of heat and a permanent incandescent material is supplied as a part of the apparatus.

The first great step in the improvement of the efficiency of gas for lighting was made on the first of these principles, in the form of the regenerative burner of the Siemens-Lungren type. There are some of these regenerative lamps in use at the present time. They may be recognized by the downward flame and the small hemispherical globe beneath the light. That form of burner was the most effective ever produced by following the first principle mentioned above, and gave the most efficient results up to the introduction of the so-called incandescent gas lighting system, which is based on the second principle mentioned above.

In the regenerative burner the increased efficiency was got by pre-heating the gas before it reached the point of combustion.

From a theoretical standpoint, the second principle enumerated above offers infinitely greater possibilities than the first. In order to obtain the highest efficiency from gas, it is apparent that it is better to obtain its maximum heating value and utilize this heat for the production of light by the introduction of some external incandescing material.

In 1826 Henry Drummond produced the first incandescent gas lamp by the introduction of the so-called calcium light, where a stick of lime was heated to incandescence by the oxy-hydrogen flame. Many forms of incandescent gas lamps have been developed since that time. Baskets were made of platinum wire and suspended beneath an inverted burner. Samples of this light were shown by Lewis at the Crystal Palace Exposition in 1883. Similar baskets have also been made from threads of magnesia. These burners were operated by compressed air. The life of the hood was limited to 50 or 60 hours. Baskets have been made from perforated sheets of various oxides suspended to the flame. None of these attempts was sufficiently successful to be of commercial importance.

The first great step in the production of a commercial incandescent gas lamp was made by Dr. Carl Auer von Welsbach. In 1880, Dr. Auer, while a student in Bunsen's laboratory, discovered that the ash from a cotton fabric saturated in a solution of erbium salts would take the form of the cotton fibers and would adhere to form a mesh of considerable strength. This finely divided ash fabric when suspended in the flame of a Bunsen burner became

intensely luminous. Erbium, however, produces an intense green light. The principle of saturating a knitted cotton fabric in solutions of these rare earths and forming an attenuated but closely adhering ash was established by Dr. Auer in these experiments and he immediately proceeded to develop this idea with a view to producing a commercially desirable light by the action of the Bunsen flame on the ash of some element. His early mantles were made from a mixture of lanthanum and zirconium oxides. The light given by this mixture was not satisfactory; the life of the mantles was short and it soon became apparent that an industry could not be developed by the use of the lanthanum-zirconium mantle.

Dr. Auer continued his experiments, using the rare earths, until he discovered the wonderful results which could be got by the use of a mantle made from thorium and cerium. Thorium at that time was a very rare element and minerals containing it in any quantity had not yet been discovered. As soon as it was demonstrated that wonderful results could be obtained by its use, however, mineralogists were interested and thorium bearing minerals were discovered in commercial quantities in Brazil as a beach sand, and in North and South Carolina in stream beds. Dr. Auer and the chemists associated with him developed chemical methods for the purification of these minerals and the isolation of the thorium and cerium for the production of mantles. The incandescent mantle as it is supplied to the market at the present time is the result of this work. While great improvements have been made in its manufacture and methods of shipment, the principle involved is exactly the same as that laid down by Dr. Auer.

When the mantle was first brought out, the principal difficulty encountered to make it a commercial success was the question of transportation and handling. This was overcome by the invention of the Rawson brothers. In it, they proposed to coat the mantle with a collodion solution in order to render it capable of being carried and installed. In the earlier history of the business, before the Rawson invention, the mantles were carried about the streets of Vienna by boys with one mantle in each hand. All mantles at the present time are coated with this collodion solution and this coating is the material which is burned off after the mantle is properly placed upon the burner.

The earlier burners were designed for use with the original lanthanum-zirconium mantle, which did not give the high candle-power given by the present mantle. Inventors thought at that time that they must have a mantle 2 or 3 inches in diameter and the burners were constructed accordingly. Various devices were used to bring about the complete combustion of the gases in these burners, such as numerous air ports, long chimneys, etc. All of these burners embodied the Bunsen principle and depended upon entraining air by the velocity of the gas at the nozzle of the check. In addition to this, various devices were incorporated in these burners to furnish an additional air supply for the outside of the flame.

The first years of the development of the incandescent gas lighting system, attention was directed particularly to the production of a burner for house and store lighting. In the last few years, however, the idea has been extended, and burners have been developed for street lighting, outside and inside gas arc lamps, cluster lamps, inverted lamps, etc.

In cluster lamps the chimneys are displaced by the use of a large globe surrounding the mantles. These lamps have not only glass globes surrounding the mantles, but a stack or draft introducer which materially assists in supplying the Bunsen flame with the necessary amount of air to complete the combustion of the gas.

Many other forms of incandescent gas burners have been developed, but all of these have been more or less fads. I might mention the DeLery type of burner, which was a burner with a number of tiny blue flames, over each of which was suspended a tassel made from the same material as the present mantle. Another type was made by suspending little pencils in the Bunsen flame. None of these schemes have proved as efficient and satisfactory and durable as the standard type of burner shown here.

A so-called intensified incandescent lamp has also been developed. In these lamps the gas or the air or both are supplied under pressure and the intensity of the light given by the mantle is enormously increased. The efficiency is also increased by this method up to certain limits. A lamp of this character has been invented which contains a hot air motor immediately above the mantle. The waste heat from the mantle runs the motor, which in turn runs a fan which fans the flame. This is known as a self-intensified gas lamp.

The most important steps in the devel-

opment of incandescent gas lighting in recent years is the successful construction of an inverted mantle burner. The first experimenters in the incandescent gas lighting field attempted to construct an inverted burner, but the mechanical difficulties in the way of producing a Bunsen burner which would work in the inverted position with the variable gas conditions existing was a problem which they were not able to solve. The old experimenters invariably used gas and air under pressure. The advantages of the downward distribution of light were so obvious that experiments were taken up again to solve the inverted burner problem in conjunction with the new thorium-cerium mantle. The mechanical difficulties in the way of burning a gas of light specific gravity in an inverted Bunsen tube have been overcome and the mantle manufacturer is able to produce a satisfactory inverted mantle with the result that to-day inverted gas burners are becoming a very considerable factor in the gas lighting industry. The success of the inverted burner depended upon the solution of a number of problems. The fresh air supply for the Bunsen tube must be protected so as not to draw in the products of combustion; the burner must be so constructed as not to flash back when lighted or after burning some time. This could be overcome by the use of a gauze, but a gauze is very objectionable on account of collecting dust and gradually stopping up and interfering with the downward flow of the gas. The burner must be so constructed as to give the necessary velocity to the air and gas mixture to carry it to the point of combustion. A successful solution of these problems has been worked out in this country. The introduction of a fresh air supply of the Bunsen tube is a matter of mechanical detail in design. The production of a proper jet velocity for the downward flowing mixture of gas and air was a question of a properly constructed syphon or raceway in the Bunsen tube between the air ports and point of combustion. The flashing back was overcome by the use of an automatic gauze. The automatic gauze or thermostat, as it is called, is a device placed in the lower Bunsen tube and performs the function of a gauze without introducing its objectionable features. When the lamp is cold the fingers of the thermostat are closed, forming a slitted cone, which prevents a flash back when the lamp is lighted. As the lamp becomes heated, the thermostat opens, leaving the Bunsen tube clear for the unobstructed flow of the gas and air mixture. The thermostat is so placed in the tube that it is not corroded by the action of the flame and its automatic movements prevent it from collecting dust. The thermostat is made by rolling together two pieces of metal which have different coefficients of expansion; for example, brass and iron. Brass expands more than iron when heated and causes the curved fingers of the thermostat to straighten out and lie against the walls of the Bunsen tube. On cooling, the brass contracts more than the iron and the fingers resume their curved position, forming the slitted cone.

It is obvious that in lighting a desk, or any place in a house or store, there is a certain disadvantage in having opaque objects below the source of light. In other words, in gas lighting, as in any other kind of lighting, the light should be thrown downward.

The incandescent gas lighting people realized the advantages of having their light without obstructions below. They also realized that it was necessary to have a chimney to increase the draught, as in an upright burner, so a little chimney was placed around the mantle and considerable air from the outside is entrained up over its surface. This chimney not only entrains more air, but it also distributes the air more uniformly over the surface of the mantle; furthermore, it is constructed so that if the mantle breaks from any unusual shocks, its particles are caught in a little pan or dish in the bottom of the chimney. The inverted incandescent gas lamp lends itself to a great many uses which were not suitable for the upright lamp. For instance, it is extremely useful in shop lighting and desk work, and in many other places where the upright mantles did not give satisfactory results. Inverted lamps installed with a flexible tubing give exceedingly satisfactory results from a standpoint of the users and are practically free from vibrations which might injure the mantle. This tube is made from spirally wound steel ribbons with an asbestos gasket. It is exceedingly strong, is not affected by heat, and does not deteriorate in use.

One of the chief objections to gas lighting was that it was inconvenient to light the lamps. This was met by supplying a by-pass so that the lamp may be turned on or off at the will of the user.

Discussion of Mr. Litle's Address Before the Philadelphia Section

J. D. Israel.—What constitutes the different qualities or grades of mantles, and what are their relative efficiencies?

M. C. Whitaker.—The quality of mantles varies directly with the raw materials which go to make them up, and the class and character of the workmanship which is put on these goods. The cotton thread, from which the basic fabric of the mantle is woven, may be a thread made from a very cheap grade of cotton with a short staple, indifferently spun so that it would have all kinds of thicknesses. Inasmuch as every defect which is in the thread is reflected in the fiber of the mantle, an uneven thread will produce a mantle of uneven texture. The kind of thread and cotton used has an important bearing on the physical and candle-power life of the mantle. A good mantle requires the use of a thread spun from a long staple cotton, and should be of at least six cords. This is essentially an expensive thread. Another factor entering into the quality of a mantle is the skill with which it is made.

The cheaper grades of mantles are made on automatic machines at a minimum labor cost. Ten mantles at a time are made on some machines, but the higher grades are made one at a time where the operator devotes her entire attention to one mantle. That also has an important bearing on the cost and quality of the product.

The cheaper grades of mantles are mounted on tin caps of very inferior quality, while the higher grade mantles are mounted on caps drawn from sheet metal. The supports used on the cheaper grades are made from ordinary iron wire, while on the high grade mantles a nickel jacketed wire is used. It is found this nickel coating will stand the action of the gas flames better than even pure nickel or pure iron.

H. Harris.—What is the average lighting performance of the downward mantle; that is, its rated candle-power at its burning out point?

Mr. Litle.—The life of one type of inverted mantle, under normal conditions, should be from 500 to 1,000 hours, and a great deal longer than that under good conditions.

Mr. Israel.—What is the life of the best upright mantle?

Mr. Litle.—About the same. I have seen them burn three and four years, but that would not be an average. A mantle might hang together, but not give as much light at the end of a thousand hours as it did at the beginning. In a thousand hours the candle-power of the mantle would drop about 30 per cent. For a poor mantle the drop might be from 60 per cent. to 70 per cent. The modern mantle is made to give a very much mellower light than the mantle used four or five years ago. That accomplishes two things: It means that the mantle is less objectionable from a lighting standpoint, and at the same time that the mantle lasts longer. The modern mantle does not deteriorate so rapidly in candle-power as the old-style mantle.

Mr. Harris.—How does the depreciation in candle-power take place?

Mr. Litle.—The drop in the first 100 hours is more rapid than afterwards. If the drop is 30 per cent. in one thousand hours, the drop would be ten per cent. in the first 100 hours. The same holds true with an inverted mantle.

Mr. Harris.—What is the consumption of gas in the downward mantle, operated under the rated candle-power?

Mr. Litle.—From three to three and five-tenths feet per hour. The upright burns a little more than that, from four to six feet per hour, at two-inch water pressure.

Mr. Whitaker.—The mantles that are made to sell at 25, 30 and 35 cents will give a longer life and maintain their candle-power better than those at five, ten and fifteen cents. The only reason the cheaper mantle is put on the market is to meet the demand of an enormous number of people who are not looking toward getting the full length of life in the mantle, but are looking for something which, if it drops to pieces, will not cost them much to replace.

Mr. Harris.—How are mantles marked? How would a person know what to look for in buying a mantle?

Mr. Whitaker.—The three and a half inch standard mantle is understood to have a certain gas consumption requirement for a certain yield of candle-power. There is some variation between different mantles of the same class, but not very great, probably five or ten per cent., and mantles are purchased by gas companies and lighting engineers according to size and style and quality. There is no fixed standard of gas consumption or candle-power yield specified in the purchase of these mantles. The quality of the mantle which a gas com-

pany or lighting engineer will use is largely got at on the basis of the number of mantles required per burner per year for maintenance.

G. R. Green.—Under what conditions should the different kinds of burners be used?

Mr. Litle.—For lighting the interior of a store, use either the gas arc lamp or the reflex lamp on a chandelier with a round globe. For a store window use a reflex lamp with a mirror glass reflector, hanging the lamp high in the window, and, if possible, if the window had a deck, place the lamp immediately above the deck.

In a house, I would use the reflex lamp almost exclusively, because we know that that particular lamp gives a more useful light below the horizontal than the upright burner.

In a dining room I would use an art dome of some sort, not more than five feet eleven inches above the floor, so that the fringe or metal surrounding the bottom of the dome would shield the source of light from the eye.

In a factory use an arc lamp with a reflex burner for the various machinery and benches, because that will stand any amount of vibration, and it can be shifted easily without injury.

Mr. Harris.—Take a store 25 feet wide, 100 feet deep, with a twelve-foot ceiling; how many four-burner gas arcs would you install there to get good general illumination, so that the goods on sale would be all well lighted?

Mr. Litle.—Place them fifteen feet apart and eight feet from the floor. But it also depends upon the papering in the room, the tinting of the ceiling and walls, etc.

Mr. Harris.—Is that applicable to a room 25 feet in width and with one row of lamps?

Mr. Litle.—Yes. Put the lamps down the center in a 25-foot store; and that would be plenty; but the store could be lighted better with the reflex lamp.

Mr. Israel.—Do you make a test of a few samples of mantles from each department at the end of a day's work, and class all that come within a certain percentage of the requirements as high grade mantles?

Mr. Whitaker.—The testing department takes samples of all the factory output, and these are carefully tested, both for physical strength and candle-power and shrinkage, by special devices and machines for that purpose. These tests serve to check the quality of the output of each department. The grade of the mantle is determined by the quality of the material and workmanship used in its manufacture.

H. Calvert.—Does the presence of an enricher in the gas increase the candle-power of the mantle?

Mr. Litle.—Yes; but not in any regular or large proportion. We are apt to forget the efficiency of the mantle, and that with an increased candle-power in the water gas we get a corresponding efficiency in the mantle, due to the greater number of heat units.

Mr. Harris.—Is not the life of a mantle dependent upon the variation in pressure?

Mr. Litle.—No; unless it is extremely high, say, one-half or three-quarters of a pound. A mantle will burn at one pound natural gas pressure if the burner be adjusted for it. Its life, however, would not be quite as long as with a lower pressure. A constant change in pressure would not injure the mantle. Low pressure alone will not injure it.

Meeting of the New England Section, March 12th.

Moore Tube System of Lighting

By H. E. Clifford.

Whatever type of illuminating source we may happen to be most interested in as individuals, we all have a general interest at least in any new development in methods of lighting. I therefore felt that the Moore tube system of lighting was sufficiently remarkable in character and had become sufficiently standardized and commercialized to merit some few words in regard to it, relative to the system and to its operation. I had occasion this last spring to make some study of the Moore tube system and whatever may be our feelings as to the advantages or disadvantages of that system, it certainly has some remarkable properties from many points of view. The Moore tube system makes use of the light produced by a high voltage discharge through a gas under high vacuum. I think there is some misconception about this, perhaps not general, but I have found more or less, as to the particular manner in which the light itself is produced. The tube is of glass, one and three-fourths inches in diameter and ranging from 20 to 200 feet in length. The pressure of the inorganic gas in the tube is in the neighborhood of 1/10 of a millimeter, and through this gas is passed a high voltage discharge. In its present commercial operation, the discharge is taken from the secondary high potential side of an ordinary 60-cycle transformer. This differs entirely from the original conception, which Mr. Moore had, which involved the jump spark principle, as I can best describe it, in which the inductive discharge produced intermittently in a tube of gas was relied on for the illumination. The tube is simply run on the lighting circuit and power supplied at 60 cycles. The transformer which produces the high voltage is entirely encased in a steel casing. It is impossible, therefore, unless you break through that casing, to come in contact with the high voltage terminals. From these high voltage terminals are run in the first place, carbon electrodes, and the character of that carbon is highly important in determining the efficiency of the system. These electrodes are sealed in the vacuum tube, and the tube runs about through the area to be illuminated, without wires, without any device absolutely, so far as the source of illumination is concerned, other than the glass tube to which I have referred.

In any system of illumination it seems to me there are certain questions which we all agree as being important athough we may differ as to their relative importance, and I may briefly refer to some of these in connection with this Moore system. In the first place as to its reliability, I think so far as my own observations have gone, and of course they have been naturally somewhat limited, that there is no question whatever as to the reliability of the apparatus. I have never known in the inquiries I have made of persons using the Moore light, of any such effect as short circuit. I have never known of anyone coming in contact with the high potential. In fact, if the tube is broken the circuit is interrupted, since the tube begins within this sealed casing. It is out of the question even if one broke the tube entirely in his hands for him to come in contact with the high potential.

The life of the tube, as far as can be seen, is very great. I have seen one tube which has been running for 3,000 hours. I could see no blackening near the electrodes or on the electrodes outside of the steel casing itself. Taking the efficiency figures given me at the time the tube was started, and comparing these with the efficiency as measured by myself at the time I made the investigation, I could not find that there was any perceptible change.

Electrical discharges which take place in rarefied gases tend to raise the vacuum. That same sort of thing takes place in the Moore tube and it must of necessity be allowed for, and there needs to be some sort of device to prevent this increase which results with a vacuum tube. There has been issued to Mr. Moore, I think in May, 1906, a patent for a particular type of valve which is controlled in its action by the current through the tube. This particular kind of valve, in case the vacuum tends to rise, which is practically the only contingency with which we have to contend, by the slow passage of gas through a particular carbon valve, neutralizes the increase in vacuum in the tube and the normal conditions of running are maintained.

There has been, as I know, some diffi-

culty with that valve. It depends for its action upon the motion of a certain plug through a glass tube. The fitting of this plug to the tube has not been in all cases as desirable as it might have been, and the result is that the plug has stuck in some cases, the vacuum therefore rising, and the performance of the tube has been on that account unsatisfactory. I mean to say that it has not been what would be expected when the tube was operating perfectly. So far, then, as certainty of operation is concerned and so far as the life of the apparatus is concerned, it seems quite satisfactory. It is not the same as if there were any great necessity for what you might call renewal in the tube itself. Of course, I realize in making this statement that there is a necessity for renewal in case breakage takes place. Occasionally breakage has taken place, although in making inquiries among the users of these tubes that breakage is surprisingly small.

Next, as to its efficiency. The efficiency of the tube itself with the transforming device is somewhere in the neighborhood of 1.4 watts per Hefner unit. Without the transforming device the efficiency is about 1.2 per Hefner. That puts the tube, as far as light efficiency is concerned, in the neighborhood of the best new metallic incandescent lamps. It certainly very closely rivals the tungsten lamp filament. It is not equal to the Helion, but the Helion lamp is not a commercial proposition at the present time. Of course it excels the tantalum lamp. As to the number of candles per foot, that can be regulated and determined by the amount of current and by the impressed volts. Tubes are run from five to twenty candles per foot, standard one and three-quarter inch tube in each case. Twenty candles per foot is not used except for the so-called photographic tubes, which are intended for high actinic power. Five candles per foot I found in three installations, but I found most of the tubes were standardized in the neighborhood of 10 to 14 candles per foot.

Now for some figures in regard to the relation of performance to some of the constants of the tube. During the first 100 hours after the tube is under operation, the Hefners per foot in the particular figures which I have here, rise from about 11.8 to about 13.2. Therefore, up to about 2.200 hours, there was no particular change. There was a very slight increase in the Hefners per foot, the voltage impressed on the tube being quite constant. I take it that the change in the Hefners per foot at first is due to the readjustment of the vacuum due to the passage of the current. I have no doubt there are certain gases on the electrodes and on the walls of the tube which are expelled by the passage of the current. As for the relation between Hefners per foot and the line voltage, it is almost exactly a linear one. Starting with 12.5 Hefners per foot at 200 volts, the Hefners at 220 volts on the low voltage side is about 14.3. You see, therefore, that this brings out another important point in connection with this source of illumination—namely, that the sensitiveness to rise in voltage is very much less than it is in any other source of illumination depending on electricity for its power. An increase of something over ten per cent. in the voltage causes an increase from 12.5 to 14.3 per cent. in the candle-power, that is to say, less than ten per cent. for an increase of roughly eleven per cent. in the voltage. Again, the efficiency improves after the tube is started, increasing after the tube has started up to the first 100 hours just exactly as the Hefners per foot increase. The relation between the efficiency and the line voltage is practically a horizontal line. In other words, the watts per Hefner do not change greatly. That is to say, the change is so slight that we do not need to consider it with a range of line voltage from 200 to 220 on the low voltage side. The Hefners per foot with relation to the total watts per foot is also very nearly linear. Starting with 6.1 Hefners per foot at ten watts per foot and running up to 25, the Hefners per foot increase to 25. The amperes and the Hefners per foot also form a linear relationship. As to the efficiency of a tube in relation to its length, the watts per Hefner for a tube 20 feet long is about 3.2 and the watts per Hefner for a tube 180 feet long is 1.4. That includes in each case the transformer. The relation between the volts required on the tube and the length of the tube is not linear.. In other words, the volts required on the tube do not increase as rapidly as the length of the tube. For a tube twenty feet long the volts required is about 3,500 and for a tube 210 feet long the volts required on the tube is about 11,700, so that for, roughly speaking, nine to one in the ratio of lengths, the increase in volts is about 3½ to 1.

Now, as to the capacity of the transformer which is required. For the longest tube used (about 200 feet), a 4.5 kilowatt transformer is used.

Some of the new developments in the

Moore tube are an arc light tube, so-called, which consumes less than the wattage of an enclosed arc and gives more light than the enclosed arc.

An objection, it seems to me, which may be offered to the Moore tube, is its power factor. The highest power factor I know in this tube is 78 per cent. That is in the New York post-office. The lowest power factor of which I know is 60 per cent. I mean the power factors of which I know from actual experience. That is a real objection to the Moore tube. Unless you can get a power factor which is greater than 60 per cent. we have a very serious difficulty in the use of this source of lighting. But from information which I have received I understand that the low power factor is in very many cases corrected by correcting the valve action, and that a power factor of 60 per cent. is in almost every instance an indication of unsatisfactory working of this controlling valve for regulating the vacuum.

One of the newest developments and to me one of the most interesting developments which has very recently taken place, is the production of the Moore tube which does not return to the transformer. The ordinary Moore tube starts at one of the terminals of the transformer and returns, after running around the room, to the other terminal of the transformer. They have recently been working with a tube of moderate length which does not return to the transformer. Its efficiency I cannot state. It is not at present as good as the efficiency of the tube which does return to the transformer, but it is rather interesting as indicating the possibilities. That, of course, is a matter of some importance when lighting a corridor. If we have got to go up on one side of the corridor and back on the other we are wasting a great deal of light. You may say, why don't you run a few Hefners per foot? You can do that, but not at as good an efficiency, and we have the expense of a double tube.

As to the expense of the Moore tube, it has been greatly lessened. It is now in the neighborhood of two to three dollars per foot, depending on the length of tube installed. I do not wish at all to give the impression that I am an advocate of the Moore tube system of lighting. I investigated the matter because I was interested personally in doing so and also for others. It is a very interesting method of lighting and it seems to me it possesses advantages utterly aside from its efficiency. Take, for example, an incandescent lamp which we will put on basis on one watt per candle. We know perfectly well the illumination we will get with such a lamp will be dependent a good deal on what the candle-power unit is, on the use of shades; in other words, on the question of diffusion.

To say that the Moore tube takes so many Hefners per watt, indicates not all that there is in that tube. The diffusion of light is wonderfully perfect. The light is not glaring to the eyes, in my judgment. I can look at a Moore tube with less trouble than I can look at a mercury lamp and with very much less than I can look at an incandescent light. I took measurements of the after-images and found that the after-image duration is less with the Moore tube than with the mercury light and much less than with the incandescent lamp.

We may speak of the improvement of distribution of the other lamps by means of Holophane globes. We may also improve the efficiency of the Moore tube by putting some enamel paint on the tube, and the efficiency is then very close to one watt per Hefner.

This Moore tube opens up a very interesting field, and while I cannot join in with all I have heard in its praises, neither can I join in with all I have heard against it. One of the objections against it is that for good efficiency we require a long tube. It is practically, therefore, limited to large areas. There is a tendency to breakage, and of course if it breaks the whole system goes out. There is the advantage, however, that it may be installed after the building has been erected without any disturbance. There does not have to be any concealed wiring so far as the illumination of a particular area is concerned. We have merely the transformer and the tube which gives the light. Of course we have to lead the wires up to that transformer, but so far as the source of illumination is concerned, the distribution of the light is made without wires. What the future of the system is, of course, must be determined later.

Discussion on Mr. Clifford's Address on the Moore Tube

W. J. King.—Can the color of the light be changed, and if so, how?

Professor Clifford.—There are colors which are standard, exactly as the colors of the flaming arc are standard. There is a golden yellow tube which has the efficiencies which I have mentioned, and also

a pinkish tube. Then there is the white tube, which has an efficiency only about half as good. Why that relationship should hold is not quite clear. It holds also for the flaming arc, that the white arc with barium salts is about half as efficient as that with calcium salts. It is the same here. I saw one white tube in operation and made some comparisons of color, and I must confess that it seemed to me that matching was just as good under the white tube as with daylight. These colors I have mentioned are the standard colors.

Mr. King.—How are these colors obtained?

Professor Clifford.—I am really in no position to give any information on that particular point.

N. W. Gifford.—Professor Clifford has quoted Hefners in some instances and candles in others. Will he kindly quote the value of a Hefner?

Professor Clifford. — Eighty-eight hundredths of a candle. The reason I quoted Hefners was that the measurements were made by a standard Hefner lamp. I have not therefore transformed them.

J. S. Codman.—You said the electrodes were carbon. How far do they project into the tube?

Professor Clifford.—The electrodes project into the tube something like eight or ten inches, without regard to length of tube.

Mr. Codman.—Is the tube self-starting?

Professor Clifford.—Yes, absolutely self-starting. When I first looked at the tube I expected there would be some halting like that of the mercury lamp. When starting with the jump-spark, we have, every now and then, to make a number of contacts before we get the arc going. I tried that—I tried opening and closing the switch again very quickly a number of times and not once did I find the tube fail to respond immediately.

Mr. Codman.—You mean to say that the arc will jump several hundred feet?

Professor Clifford. — Yes. Of course there is no reason why it should not do that when we consider the pressure. I tried that by closing and opening the low voltage circuit and even with rapid opening and closing, in no case did I fail to make the arc respond. There was another thing which I noticed that was quite interesting. I do not know the cause, but in the white tube it seemed sometimes almost as if there was sort of a spiral in it. In other words, the steadiness of the white tube on 60 cycles was not so good as the steadiness of the yellow tube, as I looked at it.

J. W. Cowles.—As I remember the latest tubes that I have observed, they had a very pinkish hue. Is that what was referred to as the golden yellow?

Professor Clifford.—Some are pinkish.

Mr. Cowles.—They did not impress me as being golden yellow. I assume, however, that must be what was referred to. Has the Moore Electrical Company made any attempt to operate the tubes on direct current systems—that is, by means of motor generators?

Professor Clifford.—You mean on alternating system so far as the tube is concerned, but supplying the power with a motor generator set?

Mr. Cowles.—Yes; I judge that inherently alternating current is essential on the tube end of it. I see no reason, however, why it should not be operated on direct current, although with complications and loss of efficiency.

Professor Clifford.—I do not think it has been tried.

Mr. Cowles.—Aside from the standard of efficiency, which would be more desirable, the yellow or the white light?

Professor Clifford. — The candle-power per watts is bound to be higher in lights which have a yellowish tinge. Personally I am satisfied by the yellow tube little better than I am by the white. Of course in color working the white tube has decidedly the advantage. If we try to match colors under the yellow light, all our yellows are accentuated and all our blues are deadened, but with the white light we can match delicate lavenders, etc., and we may also match colors at the red end of the spectrum as well. It is rather a psychological question, it seems to me, as to what light seems most satisfactory to be used for daily comradeship, so to speak. The white light seems to me cold, and I had the impression that it was blue when I first saw it, but it seems a very good white. I, however, prefer to stay under the yellow.

W. E. Holmes.—If a four and a half kilowatt transformer is required for a 200-foot tube, would the proportion be the same for a different length of tube?

Professor Clifford.—Tubes forty to seventy feet long use a two kilowatt transformer; 80 to 125 use a two and three-quarter kilowatt; 130 to 180 use a three

and a half; 190 to 220, a four and a half. It does not increase quite with the length of tube.

Mr. Codman.—Is the nature of the gas a secret?

Professor Clifford.—I do not know that it is, but I do not happen to know the various gases they use.

Mr. Codman.—Is the frequency of 60 cycles essential?

Professor Clifford.—Only in this way, that the tubes do not work as well on 25 as on 60 and not as well on 60 as 133.

Mr. Codman.—How does the power factor vary with the length of tube?

Professor Clifford.—That is something I cannot answer. The only tubes on which I measured the power factor were the longer tubes and I have no information as to how the power factor varies with the length of the tube. All those I have measured were installed in rooms of considerable size.

John Campbell.—What effect, if any, has the temperature—winter or summer—on the tubes?

Professor Clifford.—I think so far as my information goes it has none. The tube, so far as I could judge, runs cooler than the mercury arc tube. This I found by placing my hand and cheek against the tube.

A. Sampson.—Is mechanical injury likely to affect it in common practice—say vibration, etc.? Do they get punctured very often?

Professor Clifford.—That is a difficult question to answer, for the reason that there are not many of these tubes in use, comparatively, but I cannot find that people who have used them have suffered much from breakage of tubes due to vibration or from settling. In the instances I have in mind where tubes have been broken, it has been by injuries entirely apart from such causes.

Mr. Sampson.—Are these joints made up as regular sealed joints? Are they blown in?

Professor Clifford.—The tubes are put together simply by the regular glass blowing process.

Mr. Simpson.—In case of a broken tube, I suppose it must be sent back to the factory?

Professor Clifford.—That, of course, is a real difficulty at present. If one had an installation here in New England there is no place nearer than New York to procure a tube. You see, the amount of feet of this tubing installed is not great at present. It is several thousand feet, but it is not great as such things go. The result is that the number of agencies is limited. It seems to me that those who are installing this system have the courage of their convictions. I know there was a plant recently installed just outside of Springfield, Mass. Of course, there is nobody here in the New England States who can make repairs on that tube if anything goes wrong, so that it is a real difficulty at present.

PROCEEDINGS

Papers Read Before Technical Societies

DISCUSSION

Lighting of School Rooms

By N. W. Gifford.

Read before the New England Association of Gas Engineers.

The school rooms in question are finished in cherry or mahogany colored wood, white ceilings and walls, except where these latter are occupied by blackboards.

Rooms 12 and 22 are alike in size and arrangement of desks, 44 desks in each. In all cases the ceilings are about 15 feet high from floor.

Room 12 is lighted by four clusters of four 16 candle-power electric lamps, about 4 feet from the ceiling, and five 16 candle-power lamps on wall brackets. The clusters have opal dome shades placed under them open side up. The wall lights are clear bulbs with clear bell shaped shades. The effect is a very soft uniform light, but rather dim, and very faint shadows.

Room 22 has four No. 6 Harp fixtures with 1 single upright mantle burner with side pilot by-pass. These fixtures are placed in same relative positions as the clusters in the electrically lighted rooms below. The dome shades on these fixtures are turned upside down so that no direct light from the mantle strikes the desks, but as from the electric clusters part passes through the opal shade and part is reflected to the ceiling and from there to the desks and wall. The general effect is a soft white light evenly distributed, shadows very faint. No glare on the walls and no bright light striking the eye when looking in any direction.

Rooms 17 and 27 are of the same size, but have only 36 desks each. No. 17 was lighted with 4 clusters of four 16 candle-power lamps with opal reflector above, and five 16 candle-power side lights. In this case the light was pretty evenly distributed and sufficient in quantity, but the cross shadows were annoying, and the bright lamp filaments met the eye from some point whenever raised to the height of the wall lights or the cluster. This room was afterward fitted up with 3 Nernst lamps (the 4th for some reason not being in place at the time of this comparison on the same outlets as had supplied the clusters). The lamps were placed with the glowers uppermost. In this position the direct light did not strike the eye so objectionably as it might have otherwise done. The light on the desks was considerably stronger than the others, fairly well diffused. In adjoining room there was an installation of enclosed Arc, 4 ampere, lamps with flat corrugated tin reflectors above, and lily shaped opal shades below with the open end up. This gave a very good light, pretty well diffused, and the light sources not objectionably bright.

In room 26 two mercury vapor lamps were placed in the front of the room close to the ceiling. The effect of the light on colors and complexion was ghastly. The back rows of desks got very much less light than the front. The shadows were very sharp, but being all in one direction could be avoided. At first the light seemed painful, but after a week's working with it one became accustomed to the weird appearance and did not notice any ill effects. The lamps were too bright to look at with comfort, but being so high could be avoided.

Another room was fitted with 6 Gem lamps with glass shades, which gave a strong light on the desks, but had the objection of bright sources of light.

In the following table an attempt is made to show some comparison between the various lightings.

	Brightness of light.	Light on desks candle.	Energy used per hr.	Cost per hr.
4 Gas Mantles, inverted shades...........	10.9	1.7 feet	20 cu. ft.	2.00
21 16 c.p. lamps, inverted shades..........	11.5	1½ to 1	1040 watts	10.40
21 16 c.p. lamps, shades above............	13.9	1.75 feet	1040 watts	10.40
4 Nernst lamps	13.	2.+ feet	1408 watts	14.08
4 Arc lamps	12.	1.7 feet	1792 watts	17.92
2 Mercury lamps	15.	4 to ¾	550 watts	5.50
6 Gem lamps	...	3 feet	750 watts	7.50

The figures of initial brilliancy were obtained by looking at the lights through a simplex photometer, and are the readings observed on the scale, and show the difference in terms, the values of which are not known to the writer. They do, however, show that the bare 16 c.p. lamp clusters, which gave about the same amount of light on the desks as the gas mantles, were very much brighter when looked at directly. Of course the cry is immediately raised that the gas robs the air of its oxygen.

The requirements of school room ventilation demand 50 cu. ft. of air per minute for each pupil; 30 cu. ft. are said to be necessary; therefore there is a margin of 20 cu. ft. per minute. In the above case the air robbed of its oxygen by the burning gas would be 2 cu. ft. per minute, or ¼ of one per cent. of the surplus air in rooms of this size.

Lighting of a Railroad Yard for Night Operation

By H. M. North.

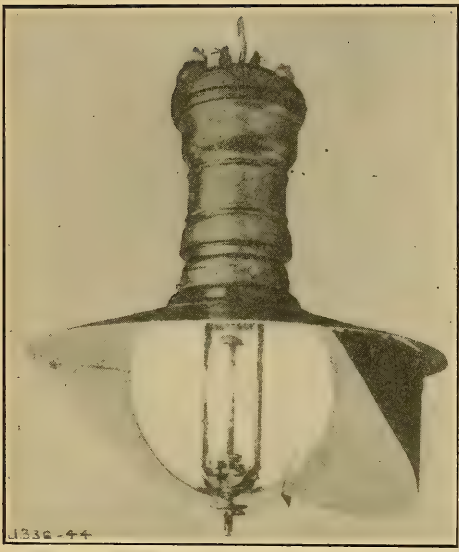
From a paper read before the Western Society of Engineers.

Yard work is dangerous, difficult and slow, during the hours of darkness and during fog. Electric lights are frequently used for yard illumination, and the switchmen supplement these by leaving a lantern on the ground opposite the end of the last car on each track. The electric lights, as ordinarily used, are not effective, and the cars are handled slowly as a result. The defect of these lights is due to their dimness, the lack of sufficient number, and their ineffective placing. To overcome this trouble on the humps and ladders, Mr. M. E. Shire, engineer in charge of the "Clearing Yards," Chicago, has developed a device like the reflector of a locomotive headlight, each light being equipped with one of these and placed so that the rays of light are directed toward the important channels of the work.

The classification yards are most in need of such a lighting arrangement, and as there are no reverse movements in this yard, not even the slight disadvantage of lines of clean light shining at times in the faces of the switchmen is experienced.

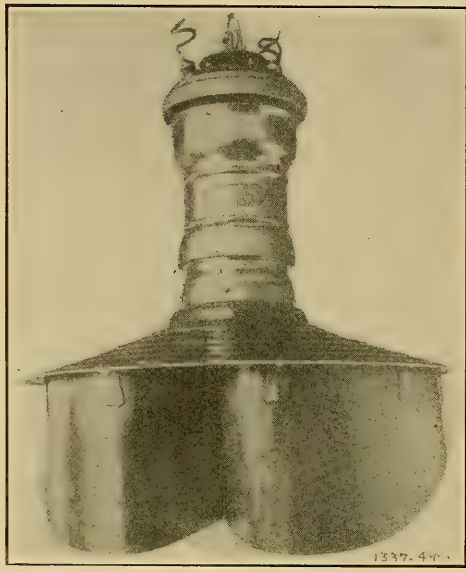
While all portions of the yard system should work smoothly and without delay, the work is concentrated at the entrances and on the ladder leads of the classification yard, as all cars must enter the yard over a single-throat track and go to their respective destinations by way of one of the ladder leads. Furthermore, the momentum required to start the cars and carry them well into the classification yard must be imparted by the grade of the throat track and ladder leads. Consequently, the maximum speed of the car occurs in its movement over the ladders, and if this speed is checked by the brakes by the rider, because he cannot see the car ahead of him clearly enough to judge of its relative position and speed, the capacity of the entire yard is thereby affected. There are no yards as far as observed where this lack of sufficient light does not lessen the operating capacity during the hours of darkness.

For lighting the ladder leads of the classification yard, one or more of these lights with reflectors is placed at proper intervals from the hump to the ladder end, on poles or on steel bridging similar to the bridging frequently used for signals; the height must be sufficient to avoid casting serious shadows from one car to another, and the reflectors properly trained to throw the rays of light where needed. In the body of the classification yard these lights are needed in greater quantity, and arranged to sweep the yard at different angles; on the outlet ladders, and in the other yards of the system, this type of reflector is undesirable, as the switching is equally backward and forward in direction, and movement toward the lights would be blinded by its rays. Accordingly, the effective arrangement in these places is a general diffused light reflected downward only.

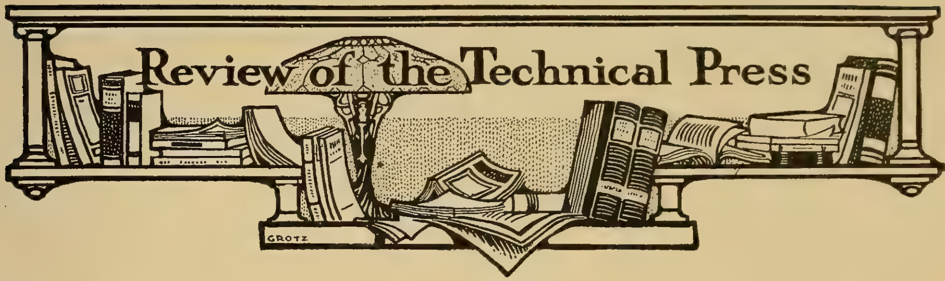


FRONT VIEW OF ARC LAMP WITH REFLECTOR DIRECTING LIGHT FORWARD AND DOWNWARD.

For the Dupo yard of the Gould system there has been developed under the writers' direction, a similar system of conserving and reflecting the rays of light to the points where they are needed. Based upon this idea, a similar type of reflector was developed by the General Electric Company, in place of the locomotive headlight type, and the reflecting surface instead of being silver plate or nickel plate, was of porcelain enamel on thin sheet steel. For the ladder leads and the portions of the classifying yards where the light rays are directed forward in one way only, there was developed the type of reflector shown in the accompanying illustrations, and for the parts of the yard where only a generally diffused illumination was needed, the skirt was omitted from this pattern. The lights were carried on systems of general current bearing lines of not greater than 440 volts, so arranged that the breakage of a single line would plunge only one part of a yard in darkness. This scheme makes its first cost, maintenance and repair economical and minimizes both the danger to employees, and the amount of interruption to work due to breakage of wire lines.



REAR VIEW OF ARC LAMP WITH REFLECTOR DIRECTING LIGHT FORWARD AND DOWNWARD.



American Items

The Small Station and the New Lamps. By Harry V. Forest, *Electrical World,* April 6th.

The writer starts with the statement that "all are agreed that we are about to see revolutionary changes in the electric lighting business principally, from the introduction of high efficiency lamps. The results to the larger companies will, of course, be a reduction of income proportionate to the rapidity with which they are introduced, but modified somewhere sliding scale rates are in use. The smaller stations are likely to get more immediate benefits with little or no loss of income." After discussing the various types of new lamps and the effect of their use from the electrical standpoint, the writer comes to the conclusion that on the whole the large electric lighting industry will be benefitted by the new lamps, and especially the small central station. Among the advantages will be the ability of electric lighting to compete more closely with various form of gas lighting. On this subject he makes the following remarks:

The improvements, recent and prospective, in quality of light and reduction of cost are not being made in the electric field alone. The vapor lamps are making rapid progress, and with the introduction of alcohol, with vastly less danger than gasoline, the electric industry will still have strong competition. The best lighted store the writer has ever seen, judging by quality, quantity and distribution of light, was lighted by an inverted mantle gasoline plant. In fact, it was simply beyond comparison with the ordinary electrically lighted store.

It is the writer's observation that most small towns are greatly under-developed from a lighting standpoint. Some towns have ½ lamp per capita; others have nearly 2, the average being about one lamp. At present a fairly well developed town will average ½ to ⅔ of the stores and ¼ to ⅓ of the houses in town using electricity. And as these new lamps will give us such a competitive advantage that we can get nearly every store and every residence, think what a great opportunity is coming for the growth of our business. This means that other towns now too small can then support a plant. And in a small town the change from 200 customers, some dissatisfied, to 400 well-pleased ones, cannot fail to reduce the troubles and add to the profit and pleasure in the electric light business.

Incandescent Lamps. By H. A. Cozzens, Jr., *Engineer,* April 1st.

An illustrated article dealing briefly with the processes used in the manufacture of incandescent electric lamps.

The Equipment of Park Resorts, *Street Railway Journal,* March 23rd.

An illustrated article describing various park features, special attention being given to novelties in illumination.

Light. By W. R. Whitney, *Sibley Journal of Engineering.*

The scope of the article is best given in the introductory paragraph:—

It is the writer's intention to briefly review the present schemes for the production of light by electrical means and to consider the possible future limitations; to

look into present efficiency compared with what we may hope to obtain. In other words, to follow along the lines of thought which the experimenter in this subject naturally follows.

An Explanation of the Short Life of Frosted Lamps

By Edward P. Hyde.

Communication from Bureau of Standards, Washington, D. C.

It has long been recognized that the useful life of a frosted incandescent lamp, taken to eighty per cent, of its initial candle-power, is only a little more than one-half the life of a corresponding plain bulb lamp. The only explanation which has been advanced, so far as the writer knows, is that the temperature of the frosted lamp is higher, due to the increased absorption by the bulb, and that therefore the lamp reaches any given point in its life, *e. g.*, the eighty per cent. point, in a shorter time than that required for the corresponding plain bulb lamp.

Without entering, at present, into a discussion of the possible temperature effects, it is sufficient to notice that if the shortened useful life can be attributed to this cause, it is very probable that, due to the same cause, the total life of a frosted lamp up to the time when the filament burns out, would also be very much less than that for the plain lamp. On the contrary, the writer has recently been informed by S. E. Doane, chief engineer of the National Electric Lamp Association, that numerous tests made at the engineering laboratories of the association indicate that if the life is taken to the time when the filament burns out, the average life of frosted lamps is the same as that for plain lamps.

It would therefore seem that some other explanation than that of the effect of temperature must be sought. A possible explanation of the phenomenon recently occurred to the writer, and was subjected to a test which showed conclusively that at least a large part of the effect, if not the entire effect, could be accounted for by the proposed explanation. A complete discussion of the investigation with the detailed numerical results obtained is to be published shortly in an extended paper on spherical reduction factors and on the effect produced by plain and frosted bulbs of various shapes on the distribution of light around filaments of different forms. It was thought desirable, however, on account of the general interest in the question of the short useful life of frosted lamps, to publish this preliminary note outlining the explanation of the effect.

If we consider the case of a new plain bulb lamp, a certain small percentage of the total flux of light emitted by the incandescent filament is absorbed by the glass envelope surrounding the filament. When the lamp is frosted a relatively large part of the light which in the plain bulb would pass through the outer surface of the bulb is diffusely reflected back through the glass. In this way a relatively large part of the total flux of light passes through the glass more than once, and so the frosted bulbs show an absorption about five per cent. greater than that for the plain bulbs.

Now, the actual absorption coefficient of glass is quite small, so that it is readily seen that if in any way the absorption coefficient is increased appreciably, the apparent absorption due to frosting would be increased greatly. This is what happens when with increasing life the strongly absorbing carbon film is deposited on the inside of the bulb. The effect is the same as if the absorption coefficient of the glass had been increased greatly. In the case of an old plain lamp all the light passes through the carbon film once, the small percentage passes through twice, a still smaller percentage three times, and so on. When the lamp is frosted the percentage that passes through more than once is very much larger, and so the carbon film has an opportunity to absorb a much larger percentage of the total flux. According to this theory, although at any time the filament in the frosted bulb may be emitting the same total flux of light as that emitted by the filament in the plain bulb, the absorption of light in the carbon film is much greater in the one case than in the other, and so the apparent intensity of the frosted lamp at any time during life is less than that of the plain lamp, the difference in intensity increasing with the number of hours the lamps have burned.

In order to test the hypothesis in a rough way a frosted spherical diffusing globe was mounted on the photometer bench. At first a new four-candle-power lamp whose intensity was known was placed inside the globe, and the apparent absorption of the globe was measured. Then an old four-candle-power lamp on the inside of whose bulb a very perceptible

deposit of carbon had formed was substituted for the new lamp. Measurements on this lamp showed a much larger apparent absorption of the frosted globe. Then the new lamp was coated with a layer of lacquer, which absorbed some of the light, and a third determination of the absorption of the globe was made. As before, the apparent absorption was greater than with the bare lamp.

Although in this way the presence of the effect was plainly noticeable, no quantitative results could be obtained, because the conditions were quite different from those existing when the bulb of the lamp is frosted. On account of the small size of the neck of the diffusing globe compared with the diameter of the globe, the largest lamp that could be used filled only a relatively small part of the inside of the globe, and so of the light diffusely reflected back by the frosted globe only a part passed through the lamp bulb. Therefore the magnitude of the effect measured in this way was necessarily small compared with that which would occur with ordinary frosted lamps.

In order to make a quantitative determination of the effect, ten compartively new lamps and twelve old lamps that had dropped to eighty per cent. in candle-power were carefully measured for mean horizontal and mean spherical candle-power. They were then sent to a lamp factory and frosted by the acid process, care being exercised to see that the frosting was as nearly uniform for the different lamps as it was possible to obtain. The lamps were then returned to the Bureau of Standards and measured. The new lamps were found to have decreased in mean horizontal intensity by about four per cent. on the average, the individual lamps agreeing among themselves to within less than two per cent. On the other hand, the older lamps were found to have decreased in mean horizontal intensity by eighteen per cent., or fourteen per cent. more than the new lamps. In other words, the apparent absorption of the frosting was approximately four and one-half times as great for the old lamps at the end of their useful life as for the new lamps. This means that if we were to assume no difference in the physical or mechanical properties of plain and frosted lamps, a lot of plain lamps which would decrease twenty per cent. in candle-power in a definite number of hours, would in the same number of hours decrease approximately thirty-two per cent. if they were first frosted. The useful life of the frosted lamps to eighty per cent. of initial candle-power would be about sixty or seventy per cent. of the useful life of the plain lamps, a value in approximate agreement with that commonly accepted. This shows that whatever effects may be produced in the lamps by frosting them, the mere absorption by the deposited carbon film, as explained above, is sufficient to account for a decrease in useful life of about thirty or forty per cent.

A single set of measurements of mean spherical intensity indicated that the new lamps had increased about the same in mean spherical candle-power as in mean horizontal, whereas the old lamps had decreased several per cent. more in mean spherical intensity. This is probably due to the uneven distribution of the carbon on the inside of the bulb.

The following experiment has been planned to determine whether there are any other elements entering than that of the increased absorption of the carbon film due to internal reflections. A large number of carefully selected lamps will be accurately measured, of which twenty lamps will be burned to the "peak" point in the curve, twenty more to a point corresponding to about sixty per cent. of the normal useful life of the lamps and forty more to the end of their useful life, measured to the eighty per cent. point. Twenty lamps will not be burned at all. All of the lamps, except twenty of those at the end of their useful life, will now be frosted at the same time and by the same process, and then all will be burned until the filaments break. In this way different points in the life curve can be reached by different paths. Thus, for example, it will be interesting to note whether the twenty lamps frosted at the end of their useful life will have the same average value as the twenty lamps frosted initially and then burned for a number of hours corresponding to the average useful life of the plain lamps. In this way it is hoped to determine whether any other elements enter to partly account for the relatively short useful life of frosted lamps.

Street Lighting

From a lecture delivered by Mr. J. D. Ross to the students in Electrical Engineering, University of Washington.

In the business districts, as the area to be lit is proportionately small, efficiency may be sacrified for some form of lighting

that adds beauty and dignity to a street. An even light of moderate intensity is required so that the attractiveness of sign lights and store windows will not be destroyed. The arc lamps have too great an amount of light at a point for even illumination, and the flaming arc is out of the question for any decorative design, as its strong reflections from windows hide all other lights and blinds the eye. It is a well-known fact that the eye tires and the pupil contracts under strong light, making the darkness beyond still darker to the passer-by. It is evident that the most effective lighting system is one using many small sources of light. This fact at once appeals to any one who sees a source of diffused light, such as the Moore Vacuum System.

The incandescent lamp is the nearest approach to the ideal for street work, especially if the glare of the filament is lessened by using a ground-glass or opal ball to diffuse the light. Los Angeles business became alive to the necessity of such a system of lighting, and their system is already famous in illuminating engineering circles. Denver, St. Paul and other cities are installing similar systems. Seattle's business men, on First, Second and Third avenues, are willing to install such a system if the city will maintain it after installation. The system will be underground, using iron poles carrying incandescent lamps, the height being about fourteen or fifteen feet. Each lamp-post is supplied with switch and cut-out in the base. The underground wires follow the edge of the sidewalk on both sides of the street, and a hand-hole in the sidewalk is used to connect with the pole. I have designed a pole for this purpose, using five lamps in the form of a triangle, all being in the same plane. Each lamp will be covered with a diffusing hood to distribute the light downward and horizontally in the best proportion, the lamp and shade being covered with a ground-glass or opal ball. The lower two are supplied with eight-inch balls, the next two have ten-inch, and the top ball is twelve-inch. Seven of these poles seventy feet apart have already been erected in front of the Franklin Hotel. The light is not intense, but it is easy to read a newspaper anywhere on the street or sidewalk. About five or six amperes will be supplied to each pole, making this system a costly one for current, but, as the incandescent lamp promises to be an efficient illuminant in the future, there is a strong possibility that maintenance cost will be greatly lessened.—*Journal of Electricity, Power & Gas.*

A Test of Arc-Lamps Carbons

From Western Electrician.

A test of Henrion carbons which was made a short time ago by one of the best university authorities in America showed the following results:

First—General observation.—
Rods straight and of uniform diameter throughout length.

Second—Rate of Combustion.—

Original weight of upper and lower carbons	63.233 gr.
Final weight after five hours' burning	61.959 gr.
Final weight after six hours' burning	
Amount burned	1.274 gr.
Amount burned per hour	0.212 gr.
Diameter of upper carbons, "solid"	0.515 in.
Diameter of lower carbons, "cored"	0.505 in.

Third—Resistance Test.—

Average diameter of cored carbons used	0.525 in.
Length between terminals	7.09 in.
Resistance	0.182 ohm
Resistance per mil-foot	74890 ohms

Fourth—Residue Test.—

Total amount burned	17.44 gr.
Residue	0.09 gr.
Ratio	0.51%

Fifth—Range.—

Hissing point "alternating current"	42 volts
Jumping point	85 volts
Arc flaring point extinguished at	85 volts

Luminescence of the Welsbach Mantle

Dr. C. Killing finds that a Welsbach mantle gives, in a flame of hydrogen burning in chlorine, a blinding greenish light. The mantle was not attacked by the chlorine. Dr. Killing concludes from this that the ceria in the mantle does not act as an oxygen carrier, and that the luminescence is an effect of high temperature simply.

Foreign Items

"Monarch" (Plaissetty) Soft Mantles

From Journal of Gas Lighting.

Our readers have been made aware, from descriptive articles published in the *Journal,* that, in connection with the Plaissetty system of mantle manufacture, entirely new ground has been broken—from the genesis of the mantle to the present stage. Plaissetty's invention itself introduced novelty; and since then there have been several improvements which have been departures from the ordinary lines of mantle making. The race at the present time among those interested in mantle production is—not so much with the object of getting the mantle itself to contribute more than it can already do in the development of the illuminating power under proper treatment, but with the object of imparting to the mantle greater durability and resistant power. And it is with this primarily in view that those whose concern it has been to evolve a greater perfection from the Plaissetty mantle have taken a unique step. They have by dint of great perseverance, investigated the problems that required solution in order to give direct to the gas consumer a mantle that could be handled as safely as any other soft textile material, and that would not need any special burner or high-pressure gas for burning off, but be simply treated in the usual way on an ordinary burner.

Regarding the soft mantle, the advantage, of course, starts with their pliability. They can be crushed up in any manner without detriment to their structure; and as now supplied, they are packed in flat circular-shaped boxes or envelopes which occupy little room, and are not so awkward for packing as the old long cylindrical shaped boxes. However the mantle is dealt with, there cannot be, without being purposely torn, any fracture in them when placing them on the burner, nor are they subject to destruction in the process of installing them in position. On being burnt off, the mantle adjusts itself perfectly to the flame of the particular burner upon which it is being used, whether the gas is being supplied at the lowest or at the highest point in the range of common or local pressures. It is most remarkable what variations in the shapes of flames are found with various burners—both upright and vertical—and even with different burners of the same type; and therefore the form of the mantle must have some effect on the amount of incandescent surface obtained. If the mantle does not fit the flame perfectly, there must be portions of it that are not incandescent; and a spotted mantle—that is to say, a mantle not fully incandescent—is a most undesirable thing. When, too, the mantle has adapted itself to the flame, the homogeneous character of the constituent filaments, it is claimed, prevents any further shrinkage. We have referred to one disadvantage of these mantles before, and we do not see that it is to be overcome, in using the flame of an ordinary burner for destroying the combustible part of the mantle—that is, the fact that time is involved before the consumer develops the maximum illuminating power. The illuminating power derived from the mantles is an ascending quality for some hours; but when it has reached its maximum, it is maintained, with ordinary attention to the burner, for considerable periods. In addition to the question of preservation from injury prior to use, and the adaptability of the mantle to any shaped flame, whether at high or low pressure, or whether the burner is of an expensive or of a moderate or low-priced type, additional strength is claimed for the soft mantle.

The Theory of Flicker Photometers

By A. P. Trotter.

From The Electrician.

I have had an uneasy feeling for some time past that my failure to appreciate the flicker photometer was due to something almost amounting to prejudice. My objections to it were based on experience with ordinary Maxwell color-discs and with the Abney adjustable sectors, rather than with actual photometers. I tried a home-made flicker photometer soon after it was described by Whitman in the *Physical Review,* and could see no great advantage and several disadvantages in it. I have read Mr. J. S. Dow's articles with interest. The title is not a very good one, for the theory of the instrument is essentially a physiological one, and Mr. Dow hardly touches on that side. I have referred to the Royal Society Papers by Mr. T. C.

Porter, which dealt with the subject of flicker, but I cannot find in them the information upon a point which ought to be considered in applying this principle to practical photometers.

Mr. Porter used, in the simplest cases, a black-and-white disc. An Abney sector is the equivalent of such a disc, for the light is alternately allowed to pass or is cut off. The Abney sector is always run well above the flicker speed for any particular degree of illumination. With a flicker photometer at the point of balance the illumination of the two halves (whatever type is used) is supposed to be identical, and the difference consists only of color. Mr. Porter's results are, therefore, hardly applicable.

The point on which I should like information is clearly indicated in Mr. Dow's second article. He says: "There is one particular speed at which, when the photometer is in balance, the flicker can just be made to disappear completely. For lower speeds the flicker can never be quite made to disappear. For higher speeds the range over which the photometer can be moved out of balance without the flicker reappearing becomes greater and greater."

I have often thought of testing this, but I have had no facilities for carrying out any photometric work for the last eight years. Mr. Dow's statement, if confirmed by actual measurements, might be expressed graphically by some such diagram as this.

The horizontal scale is one of illumination; in other words, it is part of a directly-graduated photometer bar. The vertical scale is one of revolutions per second. The shaded part of the diagram is the condition of flicker. At speed *c* "the flicker can never be quite made to disappear." At speed *a* "the range over which the photometer can be moved out of balance without the flicker reappearing" is 2 per cent., and at higher speeds "becomes greater and greater." At speed *b* "the flicker can just be made to disappear completely." What are the curves forming the boundary of the region of flicker? I have often seen flicker photometers at exhibitions and at *conversazioni* under conditions where good photometry was out of the question, and the showmen have spun the thing round until flicker was thoroughly extinguished, and have drawn attention to its absence as if that were the important matter. It appears to me that for anything like accurate work, the speed must be adjusted to the illumination, and as the object is to discover the equality of two unknown illuminations, successive approximations and adjustments of speed must be made. Is it worth it?

The "Laddite" Mantle

From the Journal of Gas Lighting.

Mr. Ladd has been at work endeavoring to improve both the lasting and the light-giving powers of mantles for some considerable time; and now he presents what he believes will be regarded as a successful issue to his labor. There is nothing special about the fabric of the mantle; and thorium and cerium are used in the impregnating solution, but the solution is composed in part of a substance which the inventor has named "Laddite." What "Laddite" is, is unknown we suppose to all but Mr. Ladd, and will remain so unless the formula escapes, or some investigator succeeds in robbing the mantle of its secret. But to "Laddite" is ascribed the power of rendering to the ash of the mantle fabric a certain amount of toughness, and of exerting an influence productive of increased brilliance. There is no doubt whatever about the extreme brilliance of the mantles seen in use on Bray burners of the ordinary type; and as to longevity, various boxed mantles were shown which had been in use—these were high-pressure ones—for over 2000 hours. One mantle had been used on a burner in London, and had proved itself capable of light-giving to upwards of 900 candles. The figure as to gas consumption was not available at the time of the visit. Another mantle had, under other conditions, given a return of 750 candles, burning over 2000 hours. For the ordinary mantles, too, Mr. Ladd claims a life of upwards of 2000 hours, under normal circumstances. Testimony from several quarters suggests that the brilliancy of the mantle is enhanced after being in use a short time. Certain it is that those seen alight were rich in their intensity; and the information was imparted regarding the maintenance of illuminating power that, for one test, the loss of light after burning for 1400 hours was only 2 per cent. The used mantles that were placed at disposal for inspection were whole, clean, unfrayed, and did not show the slightest trace of deformity. As to strength again, the mantle is credited with the ability to support seven times its own weight.

CASHIER BOOKKEEPER CONTRACTS ADVERTISING

Commercial Engineering of Illumination

Award of the Arbitrators in the Case of the City of Colorado Springs vs. the Pike's Peak Hydro-Electric Co.

The findings herein set forth constitute the award of the Arbitrators named in, and acting by virtue of an Agreement of Arbitration entered into on the 30th of January, 1907, by and between the City of Colorado Springs, hereinafter called the City, and the Pike's Peak Hydro-Electric Company, hereinafter called the Company, copy of which is attached hereto.

The matters in controversy presented to the Arbitrators arise from a franchise granted to one George W. Jackson by the City of Colorado Springs, under date of September 8th, 1898. This franchise, on the one hand, granted to the said Jackson, for a period of twenty-five years, certain rights to use, under certain restrictions, the water supply of said City for generating electricity, and also to maintain a system for the distribution of electrical energy in said City. The said Jackson, on the other hand, was to complete a water-works contract which he had previously undertaken, and was to furnish electrical energy to the City under certain conditions. This franchise came into possession of the Pike's Peak Hydro-Electric Company by assignment, and the said Company began to furnish arc lights to the City on February 15th, 1905, through the Colorado Springs Electric Company as agent.

The particular provision of this franchise relating to the controversy before the Arbitrators is contained in Section 9, which reads as follows:

"The said George W. Jackson, his associates or assigns, shall within one year after the completion of the Strickler Tunnel, and during the remainder of the term of this grant, furnish to the City of Colorado Springs such arc lights of standard 2,000 candle-power each as may be required by the City for the purpose of lighting its streets, alleys and public grounds, at the rate of $5.50 per light per month, said lights to be used from sunset to sunrise during each and every day of each and every month." . . . . . .

The City claims that the arc lights furnished by the Company are not in accordance with the provisions of the franchise, as stated above, and therefore a reduction should be made in all bills rendered by the Company to the City, whether paid or unpaid. In answering the claims set forth by the City in the Agreement of Arbitration, the Company made the contention that the City was stopped from claiming damages or rebates, at least until June 1, 1906, by reason of the fact that the City paid its bills in full to that date, and on other grounds which were duly set forth by Counsel. Both parties presented arguments and briefs on this point.

The hearings were held before the Arbitration in Colorado Springs, continuing from February 1st to 9th, inclusive, the City appearing as Plaintiff, and the Company as Defendant, both represented by able Counsel. An unusual number of expert witnesses of high character and acknowledged reputation were examined, all of whom showed an evident intention to give wholly unbiased facts and opinions.

The provisions of the Agreement of Arbitration that all evidence should be admitted led to a volume of testimony which proved in a way an embarrassment of riches. The case appeared to be of more than local interest and of wider importance than the mere money involved. These conditions necessitated a careful study and protracted consideration of every phase of the question, which, however, has enabled the Arbitrators to reach a unanimous conclusion.

Analyzing the several claims made by the two parties to the controversy, the matter has been considered under the following heads:

I. Does the phrase "Arc lights of standard 2,000 candle-power each" mean an arc lamp giving 2,000 actual candle-power, or, if not, what was the generally accepted meaning at that time?

II. Do the arc lights which the Company has furnished, when operated under normal conditions, come within the meaning of the phrase "Arc lights of standard 2,000 candle power"?

III. If the lamps furnished by the Company, when operated under normal conditions, have not fulfilled the requirements of the phrase "Arc lights of standard 2,000 candle-power," what is the extent of the overcharge measured in dollars and cents due to such deficiency?

IV. Was the service which the Company actually furnished from the lamps in use, such as might reasonably be expected, and if not, what was the overcharge expressed in dollars and cents due to defective service?

V. Was the City estopped from claiming any refund?

Considering the above questions in detail:—

I. "Does the phrase 'Arc lights of standard 2,000 candle-power each' mean an arc lamp giving 2,000 actual candle-power, or if not, what was the generally accepted meaning at that time?"

On this question the experts on both sides unanimously agree that at the date of the granting of the franchise, namely, September 8th, 1898, there was no arc light in use for street lighting purposes of 2,000 actual candle-power and therefore the phrase cannot be taken literally. The testimony of all the experts, however, shows that there was one particular type of arc lamp, namely, a direct, constant-current, series, open arc lamp taking 9.6 amperes and consuming 450 watts at the arc which was generally accepted at that time as complying with the meaning of the phrase.

II. "Do the arc lights which the Company has furnished, when operated under normal conditions, come within the meaning of the phrase 'Arc lights of standard 2,000 candle-power?' "

The Arbitrators have no difficulty at reaching a conclusion on this point since the uncontradicted testimony of the expert witnesses was to the effect that the lights furnished by the Company did not come within the meaning of this phrase.

III. "If the lamps furnished by the Company, when operated under normal conditions, have not fulfilled the requirements of the phrase 'Arc lights of standard 2,000 candle-power,' what is the extent of the overcharge measured in dollars and cents due to such deficiency?"

In arriving at an answer to this question, the Arbitrators encountered many difficulties arising from the present imperfect state of the commercial photometry of arc lights, the meagreness of evidence on some points, the various expert testimony on other points, the difficulty of selecting a satisfactory standard of comparison, and of estimating, on a dollar and cents basis, the difference in arc lamps of such widely varying characteristics.

The experts generally agreed that candle-power measurements alone do not fully express the effective values of arc lamps for street lighting, and that while the lamps used fell short of meeting the requirements of an "arc light of standard 2,000 candle-power," they had some compensating advantages.

After carefully weighing such evidence as was presented, the Arbitrators reached the conclusion, everything considered, that twenty per cent., in the present case, is a fair estimate in dollars and cents of the deficiency of the lights furnished by the Company as compared with "arc lights of standard 2,000 candle-power," both types considered as operating under normal conditions.

IV. "Was the service which the Company actually furnished from the lamps in use, such as might reasonably be expected, and if not, what was the overcharge expressed in dollars and cents due to defective service?"

The Company admitted that during a portion of the period involved in this controversy, its lamps were not operated under normal conditions, and placed in evidence a complete set of station records covering the entire period. From these records it appears that during a portion of the time the lamps were operated below their proper wattage, and for another portion of the time above their normal wattage. There appeared to be a discrepancy, however, between the wattage delivered at the lamp terminals, as computed from the station readings, and the wattage as actually measured by tests at the lamps. During the month of September, 1906, measurements were made of the exact wattage of every lamp in the City, which provided data for determining, within reasonable limits of

error, the actual amount of this discrepancy in wattage. The discrepancy thus determined proved to be 6¼ per cent., which has therefore been used as a correction constant for reducing the station wattage. The corrected wattage thus obtained was used to determine the candle-power from the data given in Prof. Matthews' tests, made on lamps taken from the City circuits. These candle-powers compared with the candle-power of a lamp operated at its normal wattage (430) were expressed in per cent., which gave the means of determining the deficiency or excess of service supplied, compared with a normal lamp of this type.

V. "Was the City estopped from claiming any refund?"

The Arbitrators requested briefs upon this question from counsel on both sides, which were carefully considered.

The Arbitrators reached the conclusion that there was no intention on the part of either party to evade the obligations of the contract. The good intention of the Company could not, however, be held as justification for an actual deficiency in service, which has been shown to exist. On the other hand, the fact cannot be overlooked that the City should have been advised in regard to a matter of such importance, before accepting the service furnished by the Company, or at least before having allowed it to continue for so long a time without protest. For these reasons the Arbitrators consider that the responsibility is divided between the Company and the City for the period to June 1, 1906, and therefore conclude that the reduction on account of overcharge for this period should be figured on a basis of 10 per cent. in place of the 20 per cent. taken after June 1, 1906.

Suburban Store Lighting

The development of comprehensive plans for electrical distribution from large urban central stations usually includes establishment of modern sub-stations in residential suburban areas. These sub-stations are properly built with the requirements of the future in mind, and there is generally a considerable amount of reserve capacity installed, both in the transmission lines and in the transforming equipment. Sometimes the load is so small at first that the line is operated at half the voltage which will ultimately be applied. From the time when such sub-stations are placed in service it becomes important to increase their business rapidly, and in such cases energetic efforts to add to the connected residential load bring their own reward.

So much attention has been given to the needs of the residence customer that the requirements of the suburban store have frequently been entirely overlooked. The conditions are much like those in the small towns and villages. It is well recognized among central-station men that the suburban store offers an attractive field for power applications, and motor-driven coffee grinders, meat choppers, emery wheels, ventilating fans, elevators and ice-cream freezers are frequently found on commercial circuits, even in remote districts. There is undoubtedly a good opening in many small towns for refrigerating plants of moderate capacity. But when one examines the lighting of stores in many villages and suburban communities it is clear that there is room for much improvement.

Many such stores still adhere to the kerosene lamp, with its large tin reflector, or depend on the decadent brilliance of poor gas for their interior illumination. Even where the incandescent lamp is used in the suburban store, the tendency is to hang the unshaded bulbs over the counters too near the level of the eye for the comfort of the customer and salesman and without the reflectors which would deflect the light upon the goods instead of scattering it all around the store. The windows are apt to be illuminated in the same general way, with bare lamps hung so that they are the most conspicuous objects in sight, in which case the merchant spends good money in lighting up part of the outdoor regions.

Given one or two skilfully lighted stores in a suburban community, others are pretty sure to follow suit, and work in this direction is seldom lost. It is largely a matter of keeping in close touch with customers.

Sometimes a central station can encourage a good deal of interest in the use of electricity in suburban towns by installing a striking electric sign of its own at some point of vantage. A good illustration of this is found in the practice of the Newton and Watertown Gas Light Company, an organization which distributes current generated by the Boston Edison Company through a broad suburban area at the west of the city proper. The Newton company has for several months maintained a brilliant "talking" sign advocating the various uses of electric light and power, on top of a building directly opposite the Boston and Albany station, where it is seen by every passenger who boards or leaves a train after dark and also by many who pass the

station daily on one of the four tracks located at this point. The fitting phraseology of this sign constitutes a telling argument in favor of extended suburban uses of electricity.

As to Lighting

By E. N. Wrightington.

From a paper on Some Commercial Department in the West, read before the New England Association of Gas Engineers.

Gas is a soft, well diffused light, pleasing to the eye, of good even quality, and cheap. In the past the principal disadvantages of gas have been the poor appearance and unadaptability of fixtures to artistic design and the inconvenience. I am a firm believer in the introduction of a better grade of gas fixture. There is nothing that has hurt the gas industry as a whole quite so much as the poor appearance of the fixtures that have been introduced. The economy of gas has been so over-emphasized that the user has felt that the only reason he was putting up with gas at all was because it was cheap, and he has therefore attempted to economize equally on the cost of the fixtures themselves. The result has been that until recently the gas customer has been only awaiting the time when he felt that he could afford to spend more money for lighting, and then put in electricity, and we have seen in all of our cities the most miserable exhibitions of dilapidated fixtures and broken mantles possible.

Now that improved fixtures have been made possible, we are selling gas not because it is cheaper than electricity, but because it is better; but the prejudice against gas had become so general that it is slow work to convince the public of its advantages aside from that of economy. This is the prejudice which leads a man to say that although he personally thinks that gas gives a better light than electricity, he is afraid to put it in his store, because his customers will think that his trade is falling off and that therefore he has been obliged to economize on his light.

There is no reason in the world, within certain limitations, why the appearance of a gas fixture should not be as handsome and artistic as that of an electric fixture. It has even become possible to turn the light upside down, and fixtures have been designed to conceal the mantle and the burner completely from view. The development along these lines should be encouraged, and we will then look for the day when a man will pay as much for a gas fixture as he is willing to pay for an electric fixture.

Even in the matter of convenience, great strides have been made. I have a fixture, a 2-arm bracket, set up in the exhibition rooms of the Gas Appliance Exchange, which is lighted by a spark lighter. This is not the usual affair with its long burner and ratchet apparatus, but is an extremely handsome piece of work which no man would be ashamed to see in the most elegant home.

We should go more into the matters of illuminating engineering. We should study the distribution curves of the gas lamps, especially the new inverted lamps, with a view to showing prospective customers how to lay out their lighting to the best advantage.

We should maintain mantles on a cost basis. This maintenance should be applied to single mantles as well as arc lamps. Of course it would be practically impossible to arrange this for isolated cases, but where there are 20 or more mantles in one installation, it would be quite possible to establish a basis of care at the expense of the customer. I have already alluded to the many cases one sees, of poorly maintained mantles. These are about the poorest advertisement we can have, and it behooves us to find some method of placing our light upon a more efficient basis, in spite of the reluctance of the customers to go to the expense of doing this themselves. If we could charge an additional sum for gas per thousand, we could do all this maintenance work gratis, as electric companies do, but it ought not to take very much sales work to show a customer that the cost of maintenance is paid by him even with electricity, and that although our charges would have to be made separate, there would still be a very large saving over the cost of electric lighting.

Many of the companies in the West control the electric light industry, as well as the gas, and it has usually been the custom not to push gas for lighting, against electricity. Where, however, there is a competitive situation, there should be a very large field for increases in the sales of gas for lighting.

Miscellaneous News

ALBANY, N. Y.—The State Gas Commission has ordered all gas companies supplying 15,000,000 cubic feet or more per annum of coal, water or mixed gas to install by September 1 next stationary photometers for testing the candle power of the gas they distribute. The purpose of this is to permit the authorities to test the candle power of gas furnished to the consumers. Photometers to be installed under this order must be approved by the State commission.

The State gas commission has received from a committee of experts, representing the gas companies of the State to be effected, a report on the matter of a standard of candle power to be established for coal, water and mixed gas supplied by the companies in this State. It is the intention of the State commission to establish a candle power standard by official order, and at the hearing given to the representatives of the companies a few weeks ago, it was suggested by the commission that possibly a standard of 16 candle power for coal gas, 18 for mixed gas and 20 for water gas would be decided upon.

The gas companies asked the commission for a little time to have eminent experts report a standard, which would be agreeable to all concerned. This committee fixed upon standards of one candle power lower in each case than the State commission had suggested at the hearing. The report says that in the opinion of the experts the candle power in this State should be 15 for coal gas, 17 for mixed and 19 for water gas. The committee of experts making the report included Dr. Alexander R. Humphreys, president of Stevens's Institute of Technology, who is president of the Buffalo Gas Company; R. M. Searle, general manager of the Rochester Railway & Light Company, and Alfred Forstall, of New York, an expert gas engineer.

The State commission will make an order establishing a State standard in the near future.

CAMDEN, N. J.—Before taking action upon a proposed bond issue for the purpose of establishing a municipal lighting plant, members of the Finance Committee of the City Council have instructed the City Controller and City Counsel to call upon the officers of the Public Service Corporation and ascertain from them, if possible, what it would cost for lighting the city after the expiration of the present contract. They were also instructed to ascertain what concessions would be made for the balance of the time that the contract is to run.

While the city voted to run the lighting plant, some members of City Council are of the opinion that better results can be obtained through private ownership.

CANANDAIGUA, N. Y.—It is authoritatively stated that the lighting commission of Canandaigua village is to investigate the light question in the village and take up the matter with the State Gas and Electric Commission in the effort to have the rates lowered. Canandaigua is now paying the highest price for lights in the State, it is claimed by those who have investigated. The commissioners will make strenuous efforts to secure something cheaper than $2 gas for Canandaigua, a result that will be greatly appreciated by the village consumers.

LITTLE ROCK, ARK. — The City Council held an extended executive session last night and decided to purchase the new electric light plant from the Argenta Light and Power Company for $50,000. The plant was completed about a week ago by the O'Neil Engineering Company of Dallas, Tex., for the Argenta Light and Power Company, and at present operates 60 arc lamps.

NEW HAVEN, CONN.—On good authority, it is stated that the committee of the Business Men's Association now investigating electric lighting and power cost will show that New Haveners are paying about 50 per cent. too much. This is being carried on along very similar lines to the insurance and freight investigations of last year.

Rates and conditions in other cities of the size of New Haven all over the country are being compared with those here, and some very interesting results are forthcoming.

Quite a number of New Haven firms have found it convenient and economical to put in lighting plants of their own, manufacturing their own current, generally from gas engine power. One of the notable instances of this is the case of the Yale dining hall, where by an elaborate system of bookkeeping, the exact cost of producing the amount of electricity used has been computed.

The figures furnished by plants of this kind will be used by the business men as a basis for some of the figures which they are getting together.

OGDENSBURG, N. Y.—The Ogdensburg Gas Company to-day announced a reduction in the price of illuminating gas from $2 to $1.90 net per thousand feet. The reduction becomes effective May 1.

ROCHESTER, N. Y.—General Manager R. M. Searle, of the Rochester Railway and Light Company, on June 18th next will read a paper, by request, before the British Institution of Gas Engineers, at the meeting of that body to be held at the Dublin International Exposition, Dublin, Ireland. His theme will be the development of high-pressure gas distribution in the United States. Mr. Searle will sail from New York on June 4th. The date of his home-coming has not been fixed.

It is possible that as a result of Mr. Searle's trip abroad, the gas works of the Rochester Railway and Light Company will be reconstructed during 1908. While in Europe Mr. Searle will visit England, France and Germany for the purpose of making a study of the "vertical retort" system of manufacturing gas, with a view to the possible introduction of the system in Rochester next year.

SAVANNAH, GA.—Many retail merchants were among the persons who enjoyed the interesting lecture of Mr. G. C. Osborne, an illuminating engineer of New York, on "Modern Artificial Illumination; Its Scientific Aspect and Practicable Application," which was given at the Chamber of Commerce under the auspices of the Savannah Electric Company last night. A stereopticon machine was used to illustrate each phase of the lecture and demonstrate the truth of the assertions made.

The subject of lighting was first taken up and the efficiency or deficiency of each lighting process was fully demonstrated. The several makes of electric lights were then demonstrated and it was shown how a more brilliant light could be received from one kind than from another without any increase in current. He displayed all the recent noteworthy developments in lamps and demonstrated their best uses. A full discussion of the cost of lighting, what it depended on and what it involved followed.

After fully demonstrating the necessity of an opinion of an illuminating engineer by showing how easily it is to change a dimly lighted space to a brightly lighted space by the proper use of shades and reflectors, by the proper number and kinds of lamps and the proper distances apart, Mr. Osborne offered the assistance of the Savannah Electric Company to help solve the problem for those who may desire.

SYRACUSE, N. Y.—The Syracuse Lighting Commission yesterday adopted a plan for inquiring into the success with which municipal lighting plants have been operated in twenty-five cities of the country.

The commission is not satisfied to accept the report made by Joseph Bondy for the Central Trades and Labor Assembly on municipal plants or other publications dealing with the subject as indicating the chances for success of a municipal plant in this city, but will attempt a more thorough investigation than has yet been made.

WICHITA, KAN.—A franchise has been granted to J. O. Davidson, his successors and assigns, for the maintenance and extension of an electric light and power system in this city. The provisions of the franchise are very much the same as those already mentioned. A few minor changes have been made, all of them, in the opinion of the council, in the interest of the people of the city. This franchise provides for a twenty-four hour service and a reduction in rates of twenty-five per cent., according to statements made by members of the council.

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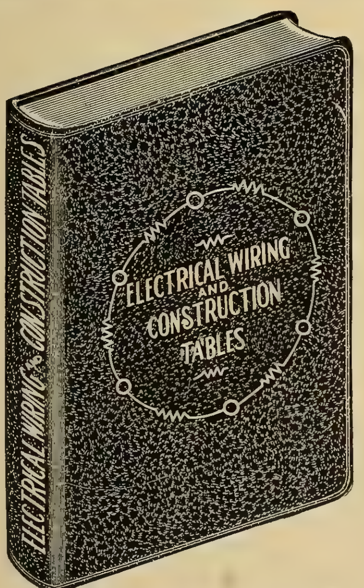

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THE ILLUMINATING ENGINEER

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Denver the "City of Lights."

By Frank C. Farrar.

Three years ago a progressive gas and electric company, with a progressive man at its head—Henry L. Doherty—began telling its city and its citizens that there should be more extensive lighting, both public and private, in order to keep abreast of the times and at the same time give to the city an air of progressiveness along original lines that would be an excellent advertising asset for the community as a whole, and at the same time a direct, local and highly beneficial advertising system for the individual business man or firm.

Denver the "city of lights" is the result.

Papers throughout the United States and Canada have had a great deal to say complimentary of the extensive and beautiful illumination in Denver. Papers in all parts of the world have mentioned this city, which styles itself the "city of lights," a peculiarly attractive and at the same time original designation.

Of course this condition was brought about through a combination of circumstances. At the time the light agitation was started there was in progress a concerted movement to "boost" the city, a movement that promptly adopted the slogan, "city of lights," as its own, and used it with vigor all of the time.

To the business men of Denver belongs the credit for giving the lighting movement headway. Many were generous enough and bold enough to accept a mere statement that lighting is good advertising and give a sign or an outlining a trial. Needless to say these have been well repaid, and the others who followed in their steps have realized entirely satisfactory returns on their outlay.

Most of the Denver display lighting, 12 o'clock and all night, is taken on the two years' contract basis, and practically all of the contracts that have expired have been renewed with greatly increased revenue, indicating the favor with which advertising lighting is regarded.

With the start given by individual business houses, the lighting question

A WELL-LIGHTED CORNER STORE.

was taken up by city authorities, and by civic bodies.

It became a part—almost the leader —in the general boosting movement.

One group of men worked up the famous "Welcome" arch, which stands, seventy feet high, just inside the Union Station in Denver, and blazes forth in brilliancy, as well as in brightly lighted letters, the welcome to the stranger and to the home-coming citizen.

This great arch, constructed of iron and bronze, was built by public subscription and cost $22,000. It has been going for a year, and is regarded as a unique and effective public undertaking. The arch is lighted by two thousand incandescent lamps.

Practically the same men who had most to do with getting the big arch undertook a canvass, free and persistent, among business men on one of the main streets — seventeenth — which runs uptown from the depot, asking all to place in front of their places of business incandescent brackets of a uniform design. The business men and owners of blocks responded, and this street is given a greatly-improved appearance.

Meantime the city administration had been taking a hand. A sum sufficient was appropriated to construct ornamental lighting pillars for a distance of a mile on the main retail street—Sixteenth. Designs were called for and carefully considered by the city art commission before action was taken.

The result is a brilliantly lighted thoroughfare, called the "white way," after New York's noted lighted district.

This lighting consists of 6½ ampere incandescent arcs, burning all night, every night, eight to each block, four on each side of the street. The same pillars that are used for the lighting support the trolley wires, so that there

SIXTEENTH STREET, DENVER'S "GREAT WHITE WAY."

are no more poles of any kind on this street. The effect is exceedingly pleasing, and the street is well lighted.

Strict ordinances govern the sign business in Denver. No sign can be extended more than six feet from the building, and all sizes must conform to the ordinances. Incidentally, the city does not permit the placing of any sign that extends out from the building if that sign is not lighted.

Due to the uniformity brought about by the ordinances the appearance of Sixteenth street is made most attractive. The soft orange of the myriads of small incandescent bulbs stand as a pleasing combination with the whiter and stronger light from the arcs. The effect of the whole is that of a mighty busy and exceedingly important thoroughfare.

There are large signs and small signs, and signs of all shapes and design. There are plenty of outlinings, from the fringe of glowing beads on the edge of a high roof, to the exterior outlining about shop-windows.

A walk down this street will convince the visitor that Denver business men are fully alive to the possibilities of lights. Every conceivable sign is illuminated, and windows and whole store fronts are brilliant in their dressing of incandescents.

In private displays several other streets vie with Sixteenth, notably Curtis, which is the chief downtown cross-town street. This thoroughfare

LOOKING UP CURTIS STREET.

OFFICE OF THE DENVER GAS & ELECTRIC COMPANY.

has countless lights for a distance within three blocks. Hardly a single business house is without some sort of illumination, exterior or interior, and the street is as bright at midnight as it is at noon.

Uptown The Denver Gas & Electric Co. office is the center of the lighting. This building is generously illuminated both inside and out, and across Seventeenth street, on the corner with the office, stands a small arch, which is maintained by the company.

On Fifteenth street, over which nearly all of the street car traffic of the city passes, there is a 70-foot billboard which is probably the most effective advertising medium of its kind in the city, if not in the West. It has been the subject of wide comment among the people and with advertising experts. Only the expression, "cook with gas," is used, but this sermon is glowingly preached to the people passing in every car by illumination reflected by a trough reflector. The lights are a foot apart.

The firm of A. T. Lewis & Son is one of the most progressive business establishments in the city. They are keenly aware of the great value of effective illumination and are always willing to try anything new advanced by illuminating experts. Their large sign which can be seen from most any point on Sixteenth street, could not be improved upon. The letters are three feet in size and lighted to bring out the outline distinctly. The window lighting of the store makes their illumination almost ideal for display purposes.

The theaters of Denver were quick to recognize the great value of artistic illumination, and it may be said that their lighting compares favorably with the best in other large cities. The Orpheum has a splendid sign which tells its story from a most effective prominence on the roof of the building. The letters of the name of the theater are used and are six feet in height. They are built on pillars. A good variety is secured with colored lamps. The outlining used brings out the strong architectural features of the building, which is considered one of the finest of its kind in the country.

These few instances of the progress Denver has made in illuminating, give some indication of what has been done to make it a city worthy of the name, "city of lights." The company is, however, mindful of the difficult problems of illumination, and for more than a year an illuminating class has been giving a considerable portion of its time to the study and deliberation of the best and most effective means of illumination. When the class was organized the recognized authorities on illumination were consulted for counsel and instruction, and since that time the members of the class have studied all phases of illuminating engineering and have skilfully applied their knowledge. The present members of the class are R. Garland Gentry, W. A. Cowling, W. E. Comer and G. E. Williamson. As the growth of the city is phenomenal, the field which these men have before them is boundless. The benefits which they have received from their study of illuminating engineering is already apparent in the illumination of the city, and it is to be expected that their advancement in the science will be reflected in the great

ORPHEUM THEATER.

amount of illumination Denver will add to what it already has. From an artistic standpoint the present illumination is certainly most creditable. But these men are ambitious to lead in applying the most advanced theories with success, and as Denver has always kept well to the fore in an electric way, their future work will bear watching with profit.

The Evolution of Railway Car Lighting

By George Wilfred Pearce.

The story of the development of the art of gas illumination of railroad cars occupies an important chapter in the annals of illuminating engineering. This member of the sisterhood of arts devoted to the manufacture and distribution of artificial light did not spring at one bound fully organized into the world, but was developed by toilsome steps and slow, and at large cost. The superb examples of the latest forms of the application of compressed gas to car lighting that are shown in the illustrations embody the results of the genius and skill of a number of illuminating engineers, whose work in that field has extended through almost thirty years, and which has been achieved at the cost of millions of dollars expended in experiments never ceasing, and in the displacement of types of apparatus of yesterday to make way for the better designed apparatus and appliances of to-day. All fields of illuminating engineering have been developed, in considerable part, by the use of inventions and discoveries of engi-

neers and chemists who, working in widely separated branches of physics, have within a century annihilated distance, sending the steamship against the wind at the velocity of 23 knots an hour, driving the locomotive at nine times the speed of Peter Cooper's first locomotive, girdling the earth with a quicker method of communication than was conceived by Puck, and thereby making New York and Hong Kong nearer together than New York and Brooklyn were seventy years ago. These men and their co-workers in physics who have added immensely to the advance of civilization in a thousand fields of the application of science to man's every-day needs, in extending the range of the human vision, in delving into the mines of chemistry, and, in burrowing for the hidden treasures of engineering, made discoveries that have enabled illuminating engineers to light the night with almost the splendid effects of the meridian sun.

The art of gas engineering for house lighting, without which the present-day method of compressed gas illumination of cars could not be conducted in a practicable and an economical way, has a history that links with it some of the noblest names among the physicists of Europe and America; just as the story of the development of electric lighting cannot be fitly told without marshalling a host of names that shine as stars of the first magnitude in the firmament "where is the choir invisible, whose music is the gladness of the world."

Germany is the native country of the Pintsch compressed gas system in world-wide use for lighting railway cars, buoys, and beacons. The early forms under this system came into use on several Prussian railways about thirty years ago. According to reports made upon the system as then installed, as set forth by prominent civil engineers from France, Great Britain, and this country, it was notably defective, and was maintained in use only because important German officers of state were financially interested in the project. About this time several gas lighted trains were in service in this country. The gas was taken from street mains and distributed by imperfect methods through ordinary types of two-light sleeve pendants, fitted with fish-tail, lava-tipped burners, and shaded by five-inch opal globes. Draughts and counter draughts often extinguished the lights, at which times the odor of the gas nauseated passengers; and when the gas was burning the light was flickering, and shadows were cast, so that the degree of value of the lighting system was far below that of the types of kerosene lamps made with especial reference to railroad requirements.

About that time Colonel William St. John became interested in the business of introducing compressed gas for car lighting. He is to-day what he was nearly thirty years ago, an illuminating engineer of the first rank; and to him as much as to any other man in North America is due the great measure of success which is to-day the portion of the Pintsch Compression Company in having a business whereby four hundred thousand barrels of crude petroleum are converted into gas for the lighting of 31,900 cars traversing the railroads of North America.

This great achievement by an American industrial corporation has been brought about since 1880, in which year a small hand compressing plant was built near the Bergen tunnel in New Jersey for the purpose of lighting a few cars on the Erie Railway.

Shortly afterward very active competition developed for passenger business between the rival Sound lines, conducted by the Old Colony Railroad which controlled the Fall River Line, and the Boston and Providence Railroad, which operated the Stonington Line. Both roads were operated by men about as near to the fossilized state of mind as ever kept behind the times in the railroad business. Both roads always fought off every man who came along with a suggestion for an improvement in service that would cost more than ten cents. But so strong grew the competition between those lines that both jumped at the chance to advertise "gas lighted trains." The Boston and Providence put on a train equipped with compressed gas, and the Old Colony put in service two sumptuously furnished parlor coaches of the English compartment type and lighted them under an imperfect compressed gas lighting system. These cars were the wonder of the time in railroad circles; but it was years afterward before five per cent. of the country's passenger cars were gas lighted.

In the meantime the Pintsch Compressing Company was organized by a number of prominent and progressive capitalists. The late Colonel Arthur W. Soper, a high-class railroad man of indomitable energy, and one of the finest men the railroad business ever knew, was made the head of the company to push the business vigorously. The present President Humphries, of Stevens Institute of Technology, became the first engineer of the company; and from the beginning to the end of his service he did great things for the uplifting of the business, whereby the Pintsch system as developed here far surpassed what ever was due to the work of the foreign engineers in the same field. Soon afterward Colonel Robert Andrews, an eminent engineer, formerly an officer of the Corps of Engineers, U. S. A., during the Civil War, became Vice-President of the company, and after the death of Colonel Soper became President. The First Vice-President, Mr. Robert M. Dixon, a graduate of Stevens Institute, and a member of the Society of Illuminating Engineers, is also the chief engineer and general manager of the company. The assembly of the illuminating engineers and the assistants thereto would crowd the noble hall in the Engineering Societies Building. When these facts are taken into consideration, one realizes that there is a large and learned body of men connected with the business of making gas for the lighting of railway cars, a business which the average man outside of illuminating engineering probably classes as involving nothing more than the work of turning on a valve connected with a street main to a tank at the bottom of the car.

Through all the years and changes, Colonel William St. John, deservedly esteemed by engineers and railroad men the country over, has been on the firing line all the time—both for the lighting of cars and for gas lighted buoys and beacons. His illustrious namesake, St. John the Baptist, "crying in the wilderness," in all probability did not have a body of men deafer to new light than this missionary of gas lighting found among the hide-bound conservatives in the railroad business of years ago, who would not give their patrons better lights than the smoky, dirty, and vile-smelling oil lamps of the patterns yet to be seen everywhere on the suburban lines of the Boston and Maine system, and in the antiquated horse cars that are operated in this city.

The main facts as to the manufac-

ture of Pintsch gas are few. It is a dry fixed gas with a large percentage of carbon, and it possesses about thrice the illuminating power of the ordinary gas made by the corporations that supply gas through street mains. Street main gas when compressed yields but one-sixth of the illuminating power of Pintsch gas. Crude petroleum, or a rich distillate therefrom, is the basis for Pintsch gas. The conversion into a fixed gas is by fractional distillation, after which the product is cooled, washed and purified in accordance with the most advanced methods, after which the gas is stored in gasometers, from which it is drawn for compression by special types of compressors to the pressure of fourteen atmospheres, after which the product is stored in gas holders, to be drawn upon as needs require for distribution through pipe lines laid at rail stations or in car storage yards. Under compression Pintsch gas loses not more than 10 to 12 per cent., whereas gas taken from street mains loses between 80 and 90 per cent. The steel tanks for the supply of gas that are affixed beneath railroad cars are tested to pressures so much higher than any strain that could come from gas that the practice tends to remind one of the saying of the great engineer, George Stephenson, "Make everything twice as strong as it need be." The automatic regulator, or gas pressure reducing valve, used for the Pintsch gas system is a remarkably efficient invention. This valve is placed under the car, so that no high pressure gas is taken into the car. With 10 atmospheres of gas in the receiver, there is the initial pressure of 150 pounds. The regulator reduces this so that the pressure of the gas at the burners is only one and one-third ounces, so that no matter whether the pressure in the tank un-

CAFÉ CAR: 100 C.P. IN EACH FIXTURE, COMPRESSED GAS, INVERTED MANTLE BURNERS.

der the car is 10 atmospheres or 1 atmosphere, the reduction in pressure from the normal stage in any degree does not sensibly reduce the illumination from the lamps.

From the days of the first installations of this system there have been many changes in the types of burners, and in forms and decorations of fixtures. In the beginning, adaptations of the Sieman's patterns of regenerative gas lamps were used. To-day the lighting fixtures include inverted burners of the company's own special forms, and double incandescent mantles that represent an enormous cost to the company for experiments conducted through many years before success was achieved. The thorium nitrate, produced from monazite sand from Brazil, that is used in the making of mantles for railroad car lamps is much more costly than the ordinary compound used for the ordinary mantles of commerce. But notwithstanding the high cost of making and distributing compressed gas for car lighting the service is very cheap—half a cent an

DINING CAR; FOUR COMPRESSED GAS INVERTED BURNERS IN EACH CEILING FIXTURE, 100 C.P. PER FIXTURE.

FIXTURE WITH FOUR INVERTED INCANDESCENT GAS BURNERS OF 30 C.P. EACH.

hour for a 60 candle power fixture fitted with double incandescent mantles. The café, sleeping and dining cars shown in illustrations contain 112 candle power in each ceiling fixture. There are now in use under the Pintsch system about 1,000 cars fitted with inverted burners and double mantles. The annual output of gas by the Pintsch Compressing Company is 720,000,000 cubic feet. The same kind of gas is used under the Pintsch system for the lighting of thousands of buoys and beacons. The buoys burn continuously day and night, with attention from light house department men not oftener than once in three to four months. The cost of gas for the types of buoys in New York harbor is less than four cents per buoy for twenty-four hours consumption. Since the introduction of gas lighted buoys in a number of harbors ships enter and depart as freely by night as by day.

Fifty years ago, as it appears by official records, whale oil, mineral sperm, and camphene in rachetless burner lamps without chimneys, af-

LATEST PATTERN OF CAR LIGHTING FIXTURE USED BY THE PULLMAN CO. ONE DOUBLE MANTLE INVERTED GAS BURNER IN EACH STALACTITE—TOTAL POWER 120 C.P. EACH FIXTURE.

NEW PATTERN IN CAR FIXTURE. 20 C.P. PER FIXTURE--DOUBLE MANTLES, INVERTED GAS BURNERS.

GAS LIGHTED BUOY; SAME SYSTEM AS IS USED IN CAR LIGHTING.

forded the illumination that served only to make visible in 2,000 passenger

MAIL CAR LIGHTED WITH INVERTED MANTLE BURNERS.

cars in the United States. About 650 cars were lighted with candles. On no car was it possible for a passenger to read by artificial light, unless he carried, as was often the case with constant travelers, a lantern. Daniel Webster, when traveling by night between Marshfield and Boston, always had two double-swing binnacle whale oil lamps fixed at the side of the car, which lamps were kept by the road solely for the great man's use. Horace Greeley, Ralph Waldo Emerson, Dr. Oliver Wendell Holmes, William Lloyd Garrison and Wendell Phillips, when traveling on lecture tours always carried a well-made lantern for use as a reading lamp on cars and in hotel bed rooms. These are indeed the days of a good degree of the realization, in a physical sense, of the prayer of the great sage for "Light, more light," and they are remindful of the very last lines written by Longfellow:

"Out of the shadows of night
The world rolls into light."

Theory and Technology

Daylight Illumination

By O. H. Basquin.

VI. Sky Illumination

(Concluded.)

UNIFORM HORIZON.

The problem of estimating the illumination due to direct sky light falling on a vertical surface, such as a window in a building front, becomes comparatively simple if the buildings opposite this window are of constant height, and at a constant distance away, thus furnishing a uniform horizon. In the actual case it is evident that the opposite buildings can never be of uniform height to an indefinite distance in either direction, but these buildings may be of uniform height for a considerable distance, indeed for as great a distance as there is any practical need of considering. In any event, in the case of a horizon furnished by buildings of various heights, one can find an equivalent horizon whose buildings are of constant height and for which the illumination is the same as that of the actual case.

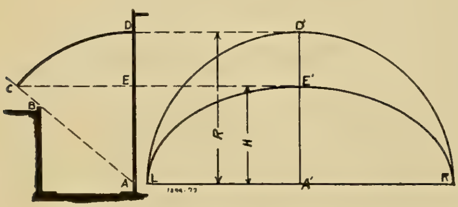


FIG. I.

In Figure I, there is shown at the left a vertical section through a street. *A* is a window in the building front *AD*. Opposite to this building is another building whose top at *B* may be assumed to be of a constant elevation, and at a constant distance from the building face *AD*. We wish to find the illumination at *A* due to the direct sky light. We may imagine a spherical surface drawn to represent the sky, its center being at *A*. The arc CD is a section of this spherical surface. If we pass a plane through the point *A* and through the top of the opposite building-front, this plane cuts the plane of the picture in *ABC*, and evidently cuts a circle from the surface of the sphere imagined to represent the sky. The opposite building cuts off all the sky light from *A*, which would come below this plane *ABC*, and we have previously found that the illumination at *A* due to the unobstructed part of the sky is proportional to its projection on the building front *AD*. The actual illumination at *A* will be equal to the product of this projected area measured in square radii, multiplied by the brightness (*B*) of the sky itself. At the right in Fig. I, we have a view of this projected sky. *LD'R* is the intersection of the sky sphere with the plane of the building *AD*. *LE'R* is the projection of the circle of the sphere

cut out by the plane *ABC*. The projected area of the sky is therefore the lune, *LD'RE'L*.

In finding the area of the lune, *LD'RE'L*, it is convenient to consider this as the difference between the area of the semi-circle *LD'RA'L* and that of the semi-ellipse *LE'RA'L*. The area of a semi-ellipse is the area of a semi-circle of the sphere projected on the plane *AD*. The area of this projected semi-circle (the semi-ellipse) is $\frac{1}{2}\pi R^2 \sin h$. This area now subtracted from that of the semi-circle *LD'R* gives us $\frac{1}{2}\pi R^2 (1 - \sin h)$ as the area of the lune. If *B* represent the brightness of the sky, the illumination at *A* in foot candles is seen to be

$$I = \tfrac{1}{2}\pi B (1 - \sin h) \quad \text{......Eq. 1.}$$

If we use *W* as the width of the street, that is, the distance from *A* to the face of the opposite building, and if we use *H* as the height of the opposite building-front, not above the ground but above the point of observation *A*, we can express sin h in terms of *H* and W, thus, $\sin h = \frac{H}{\sqrt{H^2 + W^2}}$ and our expression for the illumination at *A* becomes

$$I = \tfrac{1}{2}\pi B \left(1 - \frac{H}{\sqrt{H^2 + W^2}}\right) \quad \text{......Eq. 2.}$$

Two years ago a rapid survey of the down-town district of Chicago was made from the standpoint of illumination. The district included by the elevated railway loop is five blocks in width by seven blocks long, although a few of these blocks have been cut up rather irregularly so as to increase the whole number to forty blocks. Throughout this district the angular height of the buildings was measured at a point about five feet above the sidewalk. The widths of the streets were measured as well as the approximate lengths of the various building fronts of different elevations.

The sines of the angular heights were weighted in proportion to the length of the building frontage opposite them, and their mean value was obtained for each of the four directions in which buildings face. The angular heights presented by buildings on the south side of streets and measured on the north side at a point five feet above the sidewalk have a mean sine of 0.779; for buildings on the east side of streets, the average angular sine measured from the opposite side is 0.738, building fronts on the north side present on the south side the mean sine of 0.771, while buildings on the west side present on the east side a mean sine of 0.696. The average of these sines weighted in a similar manner is 0.745.

It is not to be assumed that the Chicago buildings are of any one height, indeed they are very far from it. About three fifths of the frontage is made up of old brick buildings four stories high, put up not very long after the Chicago fire in 1871; while about two-fifths of the frontage is occupied by higher and more modern structures. The old buildings have an average sine of about 0.66, while that of the modern structures is about 0.86.

The average street width in the loop district is about eighty feet, although the width varies from forty to one hundred and twenty feet. The old buildings are all practically seventy-five feet high, and this corresponds to the average sine of 0.66 given above. Taking the street width of eighty feet, we find that the mean sine of 0.745 is obtained by making the average of all buildings about ninety-five feet in height, while to obtain a mean sine of 0.86 we must assume the average new building to be about one hundred and forty feet in height. The Chicago building ordinance of March 13, 1905, limits the maximum height of building fronts to two hundred and sixty

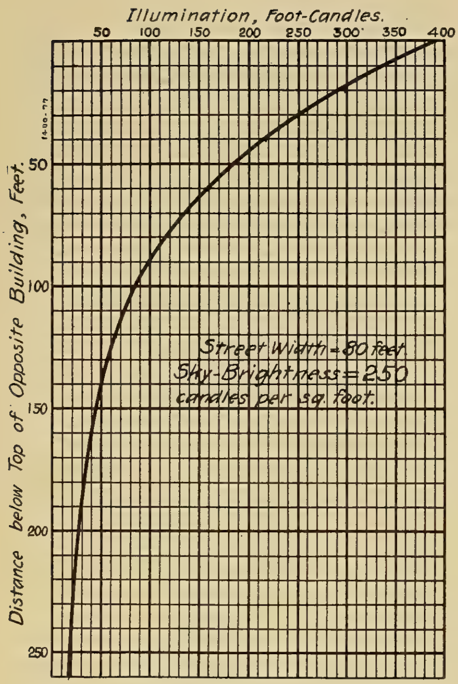


FIG. 2.

feet. It was pointed out above that although the assumption of uniform height for the buildings does not obtain in the actual case, it is still possible to select a uniform height which will give the same illumination as the actual building fronts of various heights.

The curve shown in Figure 2 illustrates the manner in which the illumination on a building front carries with the distance of this point of observation below the top of the opposite building front assumed to be of uniform height. The curve is drawn to correspond with the average condition in the loop district of Chicago, where the street width is eighty feet; and the brightness of the sky has been assumed to be two hundred and fifty candles per square foot. This value of the sky-brightness has been previously justified as a fair average for the darker days of the year. The ordinates to this curve are measured downward from the top and represent the distance of the point of observation below the level of the top of the opposite building. The abscissas of the curve represent the illumination at the point in question, and are in foot candles.

In illustration of the use of this figure, let us first assume that there are old buildings on each side of the street, both seventy-five feet high, the illumination at a point five feet from the sidewalk is then seen from the figure to be about one hundred and thirty-five foot candles. This was the average condition presumably throughout the city up to about 1890, and is to be found in many places at the present time. Next, let us assume that on one side of the street, the building is raised to ninety-five feet above the sidewalk, the corresponding illumination five feet from the sidewalk on the other side is now reduced to one hundred foot candles, as seen from the curve.

This is not a common case as the buildings are generally either higher or lower than ninety-five feet. Let us now assume that one of these buildings is raised to one hundred and forty feet in height, the average height of the modern buildings. The illumination now on the opposite side at five feet from the sidewalk is read off as about fifty-two foot candles. When the buildings have reached the height of two hundred sixty feet, then we see, at the bottom of the curve, that the illumination for the ground floors will be reduced to about eighteen foot candles, or less than one-seventh of its value when all buildings were four stories high.

Figure 3 is intended to exhibit to the eye the change in ground floor illumination caused by the increase in height of buildings in Chicago, as above described. The white area at (*a*) may be taken to represent the illu-

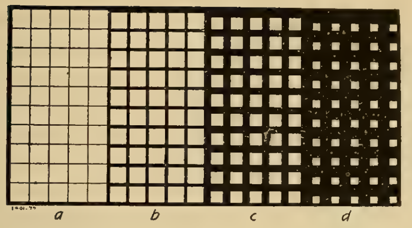


FIG. 3.

mination when all buildings were seventy-five feet high; the slightly shaded portion (*b*) represents, by its clear portion, an illumination of about one hundred foot candles, or the average condition today in Chicago. The unshaded portion of (*c*) represents the condition opposite the modern building of average height in Chicago at the present time, that is, about fifty-two foot candles; while the unshaded portion of (*d*) represents to the same scale the illumination as it will be when the city limit of two hundred sixty feet has been reached.

Of course, it is impossible to erect tall buildings facing streets, and have entirely satisfactory illumination for the lower stories. It seems, however, quite reasonable that building laws should require light colored building-fronts for all structures above a moderate height, in order that some of the direct light, which is cut off by the increased height of the building, should be made good by an increase in the diffused light reflected from the building-fronts.

The conclusion is not to be drawn that good illumination is entirely withdrawn from the building front by the erection of a taller building on the opposite side of the street. The point of good illumination is not removed from the building front, but is simply raised in its elevation above the street. If the opposite building is ninety feet high, the point receiving one hundred foot candles is at the ground level, but if the height of the opposite building is increased to one hundred and fifty feet, then we shall find an illumination of one hundred foot candles at about sixty feet above the sidewalk. The increase in height of a building then, simply raises by just that much the points of equal illumination on opposite buildings. This is shown in Figure 2 in that the ordinates are measured downward from the top of the opposite building. The ground floor in general is the one story above all others which should have good illumination, and the moving up of the points of good illumination on the building front is one which seriously injures the value of a building site, considered from the standpoint of illumination.

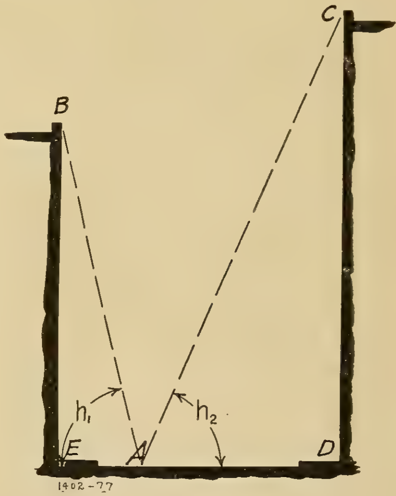


FIG. 4.

Figure 4 represents a vertical section through a street having buildings of constant height *BE* on the left side, and other buildings of constant height *CD* on the right side. At a point *A* on the street surface, we wish to find the illumination given by the direct sky light. The angular height subtended by the buildings on the left is represented as h_1, while the angular height subtended at *A* by the buildings on the right side of the street is represented by h_2.

It will be evident, from the discussion given in the development of Equation 1, that the illumination at *A* on a horizontal surface between parallel building fronts of constant height is given by the expression $I = \frac{1}{2}\pi B (\cos h_1 + \cos h_2)$. If the buildings are of the same height on both sides of the street, the maximum illumination will be at the middle of the street. If one side is somewhat higher than the other, the point of maximum illumination is to be found not far from the middle of the street, but somewhat displaced toward the lower buildings.

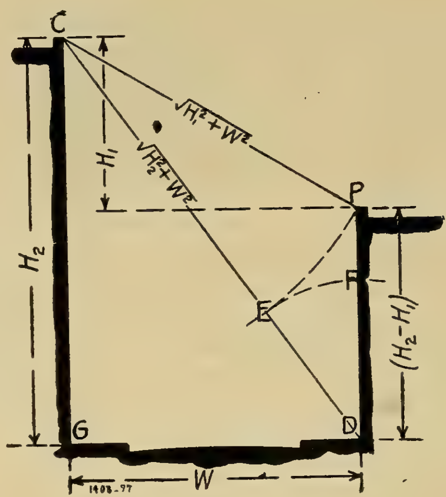


FIG. 5.

MEAN VALUE OF ILLUMINATION ON A SURFACE.

The discussion of illumination up to this point has had reference to that of a particular point on a surface. In the case of a window facing a street of ordinary width, we are not far from right in assuming that the illumination at the middle of the window is the average illumination for the whole window. This is because the angular height (h) is not very different at the top and at the bottom of the window, and because the sine of the angle, which is involved in our expression for the illumination, is roughly proportional to the tangent of the same angle. This is seen in the curve in Figure 2, the curve for any difference of vertical height not to exceed ten or twenty feet being practically a straight line. If, on the other hand, we wish the mean illumination on the face of a building, this is quite a different matter, since the angular height (h) is likely to be quite different at the top from its value at the bottom of the building front, and because the variation of the sine of (h) with the variation of the tangent is likely to change materially in that difference of angle. This is also apparent from the curve of Figure 2; when the distance apart of two points is so great as seventy-five feet, then the illumination at the point half way between those is evidently quite different from the mean illumination for that difference of height.

In Figure 5 is shown a section through a street *DG*, of width *W*, bordered by buildings of constant height *PD* on one side, and *CG* on the other. We wish to find the mean illumination of the front *PD*. At *D* the height (H_2) of the opposite building is the whole height of the building *CG*, but at *P* the opposite height (H_1) is only the difference in height of the two buildings, namely *CG* — *PD*, as shown in the figure. If we now take Equation 2, as defining the illumination at any point on *PD*, and write down the Calculus expression for the mean value of the illumination, we have

$$I_m = \frac{1}{2}\pi B \frac{\int_{H_1}^{H_2}\left(1 - \frac{H}{\sqrt{H^2 + W^2}}\right)dH}{H_2 - H_1}$$

On integration this expression becomes

$$I_m = \tfrac{1}{2}\pi B \left[1 - \frac{\sqrt{H_2^2 + W^2} - \sqrt{H_1^2 + W^2}}{H_2 - H_1}\right] \quad \ldots\ldots \text{Eq. 3.}$$

This expression has a formidable appearance, but its interpretation is comparatively simple. In Figure 5 it will be noticed that $\sqrt{H_2^2 + W^2}$ is simply the distance *CD* shown in that figure, namely, from the top of the opposite building to the bottom of the surface for which the mean illumination is required. We also see that $\sqrt{H_1^2 + W^2}$ is simply the distance from *C* to *P*, that is, from the top of the opposite building to the upper edge of the surface for which the mean illumination is required. The numerator then of the fraction in Equation 3 is simply the difference in the distances of the top of the opposite building from the bottom and top of the surface for which the mean illumination is required. With the center at *C*, we strike an arc *PE*, then the distance *DE* is the numerator of this fraction. With center at *D*, we may strike an arc *EF*, then the whole parenthesis in Equation 3 becomes simply the ratio of the distance *PF* to the distance *PD*. We may then write Equation 3 in the simple form $Im = \tfrac{1}{2}\pi B.\dfrac{PF}{PD}$

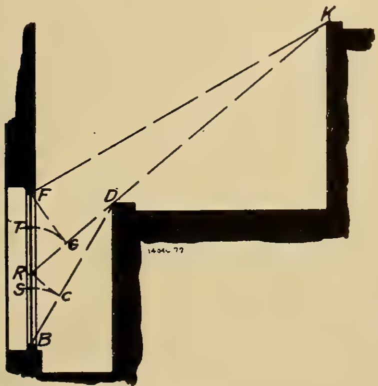


FIG. 6.

In Figure 6, is shown a section through a window in an area. For the lower part of the window the curb *D* of the outer wall of the area forms the horizon, while the horizon of the upper part of the window is furnished by a more distant wall *K*, which may be thought of as the top of an opposite building. In finding the mean illumination of such a window, it is necessary to divide it into two parts, *BR* and *RF*. This is done by drawing a line through the points *K* and *D*. The mean illumination of the lower part of the window is then found in the manner described above, the parenthesis factor of Equation 3 being the ratio of *RS* to *RB*. The mean illumination of the upper part of the window is found in a similar way, and for the parenthesis factor in Equation 3, we have the ratio $\dfrac{FT}{FR}$. To find the mean illumination of the whole window, it is simply necessary to combine these two mean illuminations in a manner which will be perfectly evident.

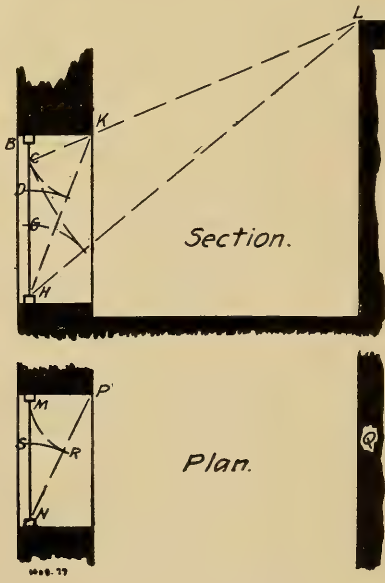


FIG. 7.

In some cases, it is desirable to find the mean illumination on a window surface which is set back some distance from the face of the wall in which the window is located. Figure 7 illustrates such a case. The upper part of this figure shows a vertical section through the window, and through the top of the opposite building *L*, which is supposed here to be of uniform height. At first, we may assume that the window is of very great width, so that the shadows cast by the sides of the window-opening do not affect the result. With this assumption, the solution of the problem is given in the upper part of the figure.

Drawing a straight line through *L* and *K*, we find that the part of the window above the point *C*, does not receive any direct light at all. Considering then the window as made up of simply the part *CH*, we find that if it were not for the over-hanging reveal, the mean illumination on this area would be $\frac{1}{2} \pi B. \frac{CG}{CH}$. We may now find the effect of the over-hanging reveal by considering the point *K* as the lower limit to the horizon, so that the window is now receiving light from the sky above *K*. On this assumption the illumination due to this assumed sky, which does not exist, is seen from the construction in the figure to be $\frac{1}{2} \pi B. \frac{CD}{CH}$. The latter illumination in the actual case is evidently negative, and is to be subtracted from the illumination found before, when the obstruction of the upper part of the wall was not considered. Hence we find that the mean illumination of the part of the window *CH*, in the actual case is $\frac{1}{2} \pi B. \frac{DG}{CH}$. The fraction appearing in this expression is the difference of the two fractions given above.

Now let us consider the effect on the illumination of the shadows cast by the projecting vertical sides of the wall opening. This is shown in plan in the lower part of Figure 34. *Q* is the top of the opposite building, which extends indefinitely in both directions. We may for the moment assume that this building *Q* is of negligible height, and that there is no projecting wall above the window; then the illumination on the window area, not counting in the shadows due to the sides of the window, is $\frac{1}{2} \pi$ B. Half of this illumination is due to the sky at the right of the window, and half of it is due to the sky at the left of the window. Let us consider the part due to the sky on the left, which we will consider to be the upper part in the illustration. The illumination due to this half is evidently $\frac{1}{4} \pi$ B. Now if we erect vertical sides to the window which obstructs light, the right vertical side will not obstruct any light from the left part of the sky. All the obstruction comes from the left side *MP* of the window. The obstruction which it furnishes may be calculated graphically as shown in the diagram, and is $\frac{1}{4} \pi B. \frac{MS}{MN}$. The remaining illumination of the window then is $\frac{1}{4} \pi B \left(1 - \frac{SM}{SN}\right)$, or we may write this more simply $\frac{1}{4} \pi B. \frac{(SN)}{MN}$. The obstruction furnished by the right side of the window to the light coming from the right side of the sky is also evidently given by the same expression.

In the above paragraph, we have

assumed that the sky has an open horizon, and we have found the average illumination of the window reduced in the proportion of *SN* to *MN*. Now if the opposite building subtends an angle which is not negligible, we may assume that the projected horizon which it furnishes is a straight horizontal line. With this assumption which is nearly true, the reduction of the mean illumination is constant, no matter how high the opposite building may be. The solution then, of our problem is that the mean illumination of the window *CH* shown in section Figure 7 is equal to $\frac{1}{2}\pi$ B. $\frac{DG}{CH} \cdot \frac{SN}{MN}$

We have seen that the total flux or light current coming from any point source of illumination is numerically equal to its intensity, and is spoken of as so many spherical candles. From this it follows that the illumination at any point on a surface may be defined as the product of 4 π multiplied by the flux per unit area falling upon that surface. The total flux which reaches a surface is, therefore, equal to the product of the area of the surface, its mean illumination and $\frac{1}{4\pi}$.

In illustration of the above, we may consider the change in the flux of light which reaches one of the old buildings in the down-town district of Chicago as building operations proceed. From the data given in a previous part of this paper, it may be seen that the mean illumination of such a building front when the opposite buildings were seventy-five feet high was about 0.95 B. When the opposite building becomes one hundred forty feet high, the average height of the modern building now in the city, the mean illumination of this old building front is reduced to 0.35 B, while this mean illumination will be only 0.096 B, if the opposite building is raised to a height of two hundred sixty feet.

We have adopted two hundred fifty candles per square foot as the brightness B of the sky on the darker days—having found 500 as the actual value in Chicago for a large number of days irrespective of their character. Now using the smaller value of B (250), we find for the above problem the following values, namely: 19.0, 7.0, 1.9 spherical candles, as the mean flux per square foot of old building front, when the opposite building is seventy-five, one hundred forty or two hundred sixty feet high respectively. If this flux per square foot is reduced from nineteen to seven spherical candles, it means that from each square foot of the building a flow of illuminous energy equal to that from a twelve candle power lamp is permanently cut off during the day time. This method of looking at the question evidently furnishes the basis for estimating the injury done to the illumination of any given building by the erection of higher buildings in its neighborhood.

Blondel's System of Arc Lighting

By Isidor Ladoff.

(Concluded.)

As regards the partition of the economizer, the novel point of the construction is that a circular opening is arranged at the center of the partition surrounded by a tube 18, which generally forms an integral part of the latter and which incases the economizer 10, which has the form of a disc or a dome or the like. Figs. 2, 3 and 7 indicate the simplest arrangement of this central tube, with a simple lower flange for the support of the cap 10. In Fig. 4 the tube is extended to form a conical reflector. In Fig. 6 this reflector is formed by a part of the tube, which is suitably bent. In Fig. 5 the tube 18 is bent at the top and not at the bottom and receives the economizer at its upper end. This cap or economizer consists of any suitable fire-resisting material. All these constructions can be used for lamps with metallic coated carbons placed side by side (one or both carbons being metallic coated), as well as for those with the carbons placed one above the other. In each case, however, they offer the same advantages—viz.: strong draft, rapid discharge of the fumes, and very perfect condensation of the latter, preservation of the mechanism, a simple and economical construction throughout, a thorough ventilation in the interior of the lamp, and an easy detachment of the casings. In order to internally clean the latter they can be made of several parts, detachable by the removal of screws or the like, or a detachable cover 27 can be constructed, as shown for example in Fig. 4. It is also sufficient to shake the casings from time to time so as to cause the deposited mineral matters to fall out through the openings 13, 23.

The merits of the Blondel system of light are considerable. We append here the results attained by Dr. W. Wedding, of Berlin, and of the Testing Bureau of New York:—

A. Blondel's system is undoubtedly superior to any other system of mineralized carbon-electrodes so far devised.

However, it has one inherent defect—the complexity of the mechanism of the pencil, requiring special machinery and skill in their manufacture. And yet—Blondel's system would certainly have attained popularity ten to fifteen years ago.

At present any system of improving the carbon electrode may be considered as belated.

The carbon arc is bound to follow in the steps of the carbon filament. Both are doomed to be superseded by metallic conductors. The future belongs to the metallic filament and the metallic arc.

Examination of an Arc Lamp "System Blondel"

By Prof. Dr. W. Wedding.

The arc lamp used for trial was a differential lamp for flame-arc light with special carbons whose composition and arrangement had been executed according to plans of Prof. Blondel, engineer, in Paris.

The lamp burned one of Blondel's carbons against a Siemens wick carbon mark A.

The arrangement is as follows:

(1). Blondel's positive carbon burns (with carbons placed over each other) as the lower carbon, contrary to the usual arrangement. Such an inversed arrangement has already been proposed by others, but has not been put into practise, certainly not for special carbons.

(2). The negative upper carbon (Sie-

mens A) is provided with a shield (economizer). Also this is known and in frequent use. The latter serves at the same time as a reflector and as such offers no new features, as same can be found in other flame-arc lamps, which are now much in use.

If therefore, something new shall be presented by Blondel's lamp, it can only consist in such a coöperation and such a combination of the different parts to a whole that thereby a really new effect and important progress for illumination by arc lamps can be attained. Should it be possible to prove by impartial trials that this is the case, against other known appearances and facts, the above combination of M. Blondel will form an invention which is worthy of patent. For this purpose I have made the following trials in the Technical High School at Charlottenburg. The lamp sent to me by M. Blondel's assistant, M. Dobkevitch, was tested on a continuous current.

In the enclosed table there is a list of the different trials.

FIRST TRIAL

The lamp was burning with Blondel's carbon of 9-mm. diameter as lower positive carbon; above stood as negative carbon a Siemens A wick carbon of 7-mm. diameter. The tensions on the poles of the lamp amounted in the average to 57.4 volts at 2.99 amperes; consequently the consumption of electrical energy was 171.5 watt. Two observers made at the same time measurements of the light powers by diametrical opposite directions to the right and left under the different angles below the horizontal. From each 3-4 readings, of every side under the different angles, the space distribution of the light on the hemisphere under the horizontal plane has been ascertained and shows by the well known integration and plane.

SECOND TRIAL

The same lamp with the same carbons in the same arrangements was measured at a lower tension and about the same intensity of current of just 3 amperes, and showed a slightly higher specific consumption of 0.132-watt. per candle.

THIRD TRIAL

The same lamp with the same arrangement of carbons with Blondel carbon of 11-mm. diameter and Siemens A carbon of 7-mm. diameter has been measured at 5.12 amperes and produced a specific consumption of 0.109 watt. (Per candle.)

FOURTH TRIAL

In order to ascertain the difference between the inverted arrangement and the one customary, Blondel 9-mm. carbon was burned as upper positive against a lower Siemens Homogen-carbon at just 3 amperes and showed a specific consumption of 0.163 watt.

FIFTH TRIAL

As Blondel's carbon burns with comparatively high tension, and in comparison with ordinary carbons, the same lamp with an upper positive Siemens A high tension wick carbon of 9-mm. diameter was burned at just 3 amperes, and produced a specific consumption of 0.746 watt.

SIXTH TRIAL

Another trial was made with the same arrangement of carbons and quality of carbons but comparative stronger carbons, also at just 5 amperes, and showed a specific consumption of 0.644 watt.

COMPARISON OF THE RESULTS OF MEASUREMENTS

A comparison of the results of the first and second trials proves, that, as otherwise known, an arc lamp at the same power of current, but higher tension burns more economically than at lower tension.

Trial No.	Kind of Carbons and Arrangement of Carbons in the Lamp.	Tension at Lamp Poles in Volts.	Power of Current in Amperes.
1	Positive carbon by Blondel.........................	57.4	2.93
	Below of 9-mm. diam................................		
	Negative Siemens A carbon above of 7-mm. diam.		
2	do.	53.9	2.95
3	do. of 11 and 7-mm. diam........................	51.6	5.12
4	Positive carbon by Blondel above of 9-mm. diam...	35.9	3.03
	Negative Siemens A carbon below of 7-mm. diam...		
5	Positive Siemens A wick above of 9-mm. diam.....	52.1	3.9
	Negative Siemens A Homogen below of 7-mm. diam.		
6	do. of 11 and 9-mm. diam........................	52.4	4.94
7	Lamp Bremem	....	2.9
8	do.	....	12.3

A comparison between the first and second trials on the one part, against the third trial on the other part, shows, that by increasing intensity of current (particularly with the comparatively small intensity of current), the economy becomes very quickly more favorable, as in the present case the specific consumption goes down from 0.132 to 0.109 watts, in other words becomes over seventeen per cent more favorable.

A comparison between the two first trials and the fourth trial shows that the Blondel inverted arrangement with an average of 0.13 watt. against 0.163 watt. under nearly the same conditions of current and tension for the ordinary arrangement, has an advantage of twenty-five per cent for Blondel's lamp. At the same time it is pointed out for practical comparison, that with the inverted arrangement the electrolytical action causes a translation of ions in the same direction and with the rising hot gases causing a considerable quieter burning, and a steadier arc light is formed.

Consequently the fluctuations during the inverted burning arc, as can be seen from the curve 1, 2, 3 are not as large by far as at curve 4. Still more distinct was this during the measurement itself, as the fluctuations during the fourth experiment under otherwise even conditions of trial, rendered any taking of photometrical distribution very difficult.

A comparison between the first four experiments and the two latter trials, shows finally the superiority of the new carbons in general against the carbons used hitherto, even if they burn at higher tension. Even an ordinary lamp for 5 amperes cannot compete against the Blondel with inverted arrangement at only 3 amperes, as the ordinary carbons, in spite of fifty per cent higher consumption of energy, furnish only one-third as much light as the Blondel lamp, the specific consumption of 0.644 watt is five times as high as with Blondel's arrangement.

RESUME

Should one desire to draw a conclusion from the above results, as to whether Blondel's lamp creates a considerably better effect, than all hitherto known lamps, and whether in the present case important improvements and really new features in respect of lighting are in question, it will be necessary to cite as comparison other results of flame-arc light.

The most favorable result of the specific consumption has been found in the Bremer lamp with carbons arranged side by side of 0.1 watt. The consumption of Blondel's lamp found during third experiment differs by nine per cent. I do not attach much importance to this difference, if one considers that 0.1 watt in a Bremer lamp can be obtained only at the exceptionally high power of current of 28 amperes (compare *Electrotechnische Zeitschrift,* year 1900, volume 27, page 3), and nearly the same result is obtained by M. Blondel with a lamp of only 5 amperes, an important improvement has thus been made. If one considers further than a 12.3-ampere lamp, according to system Bremer with 0.126 watt (see the same reprint, page 2), shows the same specific consumption, as Blondel's lamp with only 3 amperes; and if one considers at the same time that for arc lamps with smaller intensities of current the economy is very much inferior, than with higher currents (see *Electrotechnische Zeitschrift,* 1897, page 721, Fig. 30, curve a, where it can be seen that an ordinary continuous-current arc lamp for 300 watts has a specific consumption of 0.7 watts), so it is clear that a new and considerable effect has been achieved by Blondel's lamp. In general it must be admitted that M. Blondel succeeded, both by his carbons as well as by the entire arrangement, to create something new. Up to the present time no one succeeded in making flame-arc lights practically useful, and to burn with such small currents of power down to 3 amperes. That Mr. Blondel achieves this is the result of coöperation of the different elements in his lamp.

(1). He applies high percentage of minerals to his carbons, so as to give the arc the requisite power of lighting.

(2). He creates the light in the arc, by placing the positive prepared carbon below. If one reverses (like in trial 4) the carbon and burns his carbon as positive above, in watching the arc one can notice that it lights with intensity only at the top, instead, as in its inverted position, by its entire length.

(3). He has applied a shield (economizer) upon the upper negative carbon, and it effects not only a slower burning than usual, but concentrates the hot gases in such a fashion that they are consumed, producing a strong incandescence.

If the shield is not used, the lamp develops a strong white smoke, the upper negative carbon slackens and long burning without disturbance (and even without extinction of the lamp) is impossible, for the lamp without the shield is practically

useless. Consequently the success of Blondel's lamp rests in the coöperation of a number of arrangements which will lead to new and hitherto unknown progress.

I should like to mention further, that it follows from the above results, that by Blondel's lamp the distribution of light between the positive carbon, the arc (air space) and the negative carbon, must be quite different than heretofore.

With the old arrangement it is known that about eighty-five per cent of the entire quantity of light belongs to the positive carbon, about five per cent to the air space and about ten per cent to the negative carbon. It has been stated (*Electrotechnische Zeitschrift*, 1902, page 709c) that for flame-arc light with carbons arranged side by side that the arc contributes about twenty-five per cent to the development of light. If, in spite of the inverted position and the development of light, caused by reflection of the shield from the lower positive carbon, the economy of the lamp reverse against these favorable expectations, it follows that in Blondel's lamp the arc is reverse chiefly active in the production of the light. On account of the difficulties in such examinations and lack of time, I was unable to perform measurements in this respect.

(Signed) DR. W. WEDDING,

Berlin, June 17, 1903.

Professor at the Royal Technical High School, Berlin-Charlottenburg.

COPY OF REPORT, BY LAMP-TESTING BUREAU, NOVEMBER 10, 1903

Report of tests made on two Blondel Arc Lamps submitted by and tested for The New York Edison Company. Order No. 342:

In this report are given the results of various tests made on two Blondel arc lamps, one 3 amperes, 50 volts, and one 5 amperes, 50 volts. The tests consisted of:

(1). Measurements of distribution of luminous intensity, with and without enclosing outer globes respectively;

(2). Measurements of mean spherical luminous intensity, with and without the enclosing outer globe respectively;

(3). Measurements of mean hemispherical luminous intensity, with and without an enclosing outer globe respectively;

(4). General observations of the operations and behavior of the lamps.

DESCRIPTION

These lamps are, in general, of the direct current, constant potential, open arc type. The principal unusual features are:

(a). The use of a special lower carbon (the upper one being an ordinary cored carbon), which is impregnated with some chemical, resulting in a flaming arc when burning and the production of a white smoke which precipitates a white deposit on the under side of the iron shield separating the arc space from the mechanism chamber.

(b). The white surface thus formed is used as a reflector.

(c). The arc is maintained in a partial recess formed in the iron shield referred to, both carbons being automatically fed together as consumption proceeds, in order to keep the arc in this position. In other respects the lamp is similar to the familiar types.

The globe used with this lamp was an outer one, opalescent in color, and, when on the lamp, there was no open space at the top, the arc being practically enclosed.

TESTS

All the photometrical tests were made with a Matthews arc photometer.

Measurements of luminous intensity of the lamps without the globes were taken with the lamps in such a position that the arc was in the center of the mirror system. With the globes, the lamps were placed in such a position that the center of the globe was in the center of the mirror system.

In all cases, the measurements were taken in a vertical plane through the axis of the lamp, this plane being perpendicular to the plane through the supporting arms.

Each value in the tables is the mean of five or more readings, each reading being taken when the current was at its normal value.

As is customary, the lamps were burned from twenty to thirty minutes before taking any readings.

OPERATION

The lamps burn very quietly without hissing or noise, except the occasional feeding of the carbons.

The arc travels very slowly and at intervals remains stationary for considerable periods of time.

There are no deep shadows from the side supporting arms and the bottom of the lamp (due, probably, to the distributing effect of the reflecting surface referred to), and, to the eye, the illumination is fairly uniform throughout the lower hemisphere, even without the globe. The globe, of course, increased the illumination in the up-

per hemisphere, giving a more uniform spherical distribution.

As stated above, a white smoke is given off when the lamp is burning. Part of this forms the deposit referred to and part forms a haze, which, when the lamp is burning with the globe on might collect in sufficient quantities to reduce the iilumination somewhat. It is necessary to clean the white deposit off from the reflecting surface occasionally (when the carbons are renewed) in order to keep the reflector at its highest efficiency. This operation requires one or two minutes time.

GENERAL REMARKS

Carbon Consumption.—One set of carbons will burn about twelve or fourteen hours. They can, however, be burned very short, so there is very little waste.

Color.—The color is of a yellow tint and is soft and pleasant to the eye, being free from the dazzling brilliance and violet color of the ordinary open arc.

DATA AND CURVES

The unit of intensity in these computations is the Parliamentary standard candle, assumed to be equal to 1.136 Hefner units.

TABLE VI.

Consumption of Watts per Lamp.	Average Hemispheric Power of Light.	Specific Consumption of Watts per Candle.
171.5	1339	0.128
159	1203	0.132
241.2	2210	0.109
169.4	1042	0.163
154.2	207	0.746
238.9	404	0.644
.....	....	0.119
.....	....	0.126

The values of mean spherical and mean hemispherical intensities given in Table VI were obtained from the distribution data, viz.: the Rousseau diagram method.

SUMMARY OF DATA.

The value in Table VII, it will be noticed, is not consistent with the values with which it may be compared, particularly the corresponding computed values and the mean spherical values. This discrepancy may be due to the fact that new carbons were put in the lamp about this time, the original ones having been consumed. A repetition of the measurements gave the same results, so that this cause seems to be the only reasonable one.

By F. M. Fanner,
Lamp Testing Bureau.

TABLE V.

Mean Spherical Luminous Intensity of Blondel Arc Lamps.

Lamp.	Candle-Power.	Volts.	Amperes.	Watts.	W. P. C.
	By Measurement.				
3 amp. with globe	282	48.7	3.1	151.0	.54
" without globe	420	49.0	3.0	147.0	.35
5 amp. with globe	586	49.8	5.01	249.5	.43
" without globe	785	50.8	5.00	254.0	.32
	By Computation.				
	259			150.5	.58
	464			149.7	.32
	520			253.7	.49
	825			248.8	.30

TABLE VII.

Mean Hemispherical Luminous Intensity of Blondel Arc Lamps—Lower Hemisphere.

Lamp.	Candle-Power.	Volts.	Amperes.	Watts.	W. P. C.
	By Measurement.				
3 amp. with globe	363	49.7	3.0	149.1	.41
" without globe	790	50.3	3.0	150.9	.191
5 amp. with globe	765	50.2	5.02	252.0	.33
" without globe	1883	50.3	5.01	252.0	.133
	By Computation.				
	306			150.8	.49
	926			149.7	.161
	688			253.8	.37
	1650			248.8	.151

Standard of Illuminating Power and Price of Gas in Great Britain

By Charles W. Hastings.

Prompted by a short note which appeared in the March number of The Illuminating Engineer with reference to the preparation of a report to be submitted to the State of New York Lighting Commission, we propose in this article to give some particulars of the legislation which controls the illuminating power, and prescribes the standard candle value of gas supplied in Great Britain, and the several Acts of Parliament governing the same.

Before, however, entering upon this task we must traverse the statement which appeared on page 95 of this magazine: "London has, after a generation of laborious research, undertaken to fix a standard of 13 candle power for illuminating gas." This is not quite correct; the most recent legislation controlling the standard of illuminating power is contained in the London Gas Act, 1905, which provides that the Gas Light & Coke Company, the premier gas undertaking of the world, shall supply gas of *sixteen* candle power, and that the two other companies supplying London, the South Metropolitan Gas Company, and the Commercial Gas Company, shall supply gas of *fourteen* candle power.

The Act is confined to the three companies and is not a general act governing the supply of gas outside the limits of the London County Council.

The earliest legislation in connection with gas supply was provided by the Gas Works Clauses, Act 1847; but no reference was made in that act as to either the testing of the gas or the standard of illuminating power.

Under the provisions of an Act entitled the City of London Gas Act, 1868, power was given to the Board of Trade to appoint three competent and impartial persons, one at least of them having a practical knowledge and experience in the manufacture and supply of gas, who were called the Gas Referees. Up to the present time these gas referees are the authority upon all matters connected with the testing of gas in London. Prior to this date the London Gas Companies supplied gas of an illuminating power of twelve candles.

As to the outcome of the 1868 Act, a general Act, entitled the Gas Works Clauses Act, 1871, was passed, and the following clauses were incorporated, specially dealing with the matter of testing, etc.

"Clause 12. The quality of the gas supplied by the undertakers, the companies, shall with respect to its illuminating power be such as to produce at the testing place provided in conformity with this act a light equal in intensity to that produced by the prescribed number of sperm candles of six to the pound, and such gas shall, as to its purity, not exhibit any trace of sulphuretted hydrogen when tested in accordance with the rules prescribed in this Act."

The act provided for the establishment of a "testing place" at the expense of the undertakers (the companies) with apparatus, etc., that is to say:

1. For testing the illuminating power of the gas supplied.

2. For testing the presence of sulphuretted hydrogen in the gas supplied. The local authorities were empowered, under this act, to "appoint a competent and impartial person to be a gas examiner, etc."

It will be instructive, in view of

more recent legislation, which we shall call attention to, here to set out the regulations which were given in the schedule as follows:

PART I.

REGULATIONS IN RESPECT OF TESTING APPARATUS.

1. The apparatus for testing the illuminating power of the gas shall consist of an improved form of Bunsen's photometer, known as Lethby's open 60 inch photometer, or Evan's enclosed 100 inch photometer, together with a proper meter, minute clock, governor, pressure gauge, and balance.

The burner to be used for testing the gas shall be such as shall be prescribed.

The candles used for testing the gas shall be sperm candles of six to the pound, and two candles shall be used together.

3. The apparatus for testing the presence in the gas of sulphuretted hydrogen shall be a glass vessel containing a strip of bibulous paper moistened with a solution of acetate of lead, containing sixty grains of crystallized acetate of lead dissolved in one fluid ounce of water.

PART II.

RULES AS TO THE MODE OF TESTING.

1. Mode of testing for illuminating power; the effects of this difference.

The average of each set of ten observations is to be taken as representing the illuminating power of that testing.

2. Mode of testing for sulphuretted hydrogen; the gas shall be passed through the glass vessel containing the strip of bibulous paper moistened with the solution of acetate of lead for a period as may be prescribed, and if any discoloration of the test paper is found to have taken place, this is to be held conclusive as to the presence of sulphuretted hydrogen in the gas.

The Act provided for the appointment of gas examiners in Clause 29. The local authority of any district within the limits of the Special Acts, where the gas is not supplied by such local authority, may after the passing of the Special Act, from time to time appoint, or may appoint and keep appointed a competent and impartial person to be a gas examiner at the testing place provided in conformity with the provisions of this Act; and such gas examiner may test the illuminating power and purity of the gas supplied by the undertakers, etc.

The Commercial Gas Company was the first undertaking to work under the provisions of the City of London Gas Act, 1868, and the Gas Works Clauses Act, 1871. The general clauses were introduced in their Act 1875, particularly the following clauses of that act are of interest. Clause 34 provides that:

"The burner for testing the gas supplied by the Commercial Gas Company shall be a Sugg's London Argand such as immediately before the passing of this act was the burner prescribed and used by the gas referees under the City of London Gas Act, 1868, for testing gas; three or four models of which burner shall be certified as such by the President of the Board of Trade, whereof one shall be deposited with the Warden of the Standards (now the Board of Trade), one with the Metropolitan Board of Works (now the London County Council), and one delivered to the Commercial Company."

Under another Clause (52) it was enacted that: "The gas supplied by the Commercial Company shall, with respect to its illuminating power, be such as to produce, when consumed at the rate of five cubic feet per hour in the burner by this Act prescribed, a light equal in intensity to the light produced by sixteen candles."

This Company went to Parliament again in 1902, and in the Act obtained it was provided that: On and after the first day of January, 1903, the prescribed illuminating power of the Company's gas should be *fourteen* candles, and that the standard price of such gas should be three shillings and six pence ($0.84) per thousand cubic feet.

In 1876 the Gas Light & Coke Company in their special Act made provision that the gas supplied by the company should be, with respect to its illuminating power, such as to produce, when consumed at the rate of five cubic feet per hour in the burner

hereafter prescribed, in the case of common gas, a light equal in intensity to the light produced by *sixteen* candles, and in the case of cannel gas, a light equal in intensity to the light produced by twenty candles, such candles being sperm candles of six to the pound, each burning one hundred and twenty grains an hour.

The recognition of the Gas Referees was provided for in this Act, the burner for testing being the one already mentioned as being authorized for the Commercial Gas Co.

The manufacture of *twenty* candle cannel gas has been discontinued for many years, but we well remember when, in certain districts there were two sets of mains and it was at the option of the consumer to have either "common" or "cannel" gas. Powers were given under the company's act of 1870 to discontinue the manufacture of cannel gas upon giving three months' notice.

The standard up to the present time and, with the exception of the provisions of the London Gas Act, 1905, which we shall presently refer to, legislation affecting the illuminating power of gas supplied by the Gas Light & Coke Company has been enacted.

The South Metropolitan Gas Company included in their Act of 1876 the recognition of Gas Referees as provided in the City of London Gas Act, 1868, and the provisions respecting testing and illuminating power, of the Gas Works Clauses Act, 1871. The illuminating power was fixed at *sixteen* candles, and the standard burner was Sugg's London Argand, already fully described under Clause 34 of the Commercial Company's Act.

In 1900 the South Metropolitan Gas Company were before Parliament and by their Act it was provided that:

"On and after the first day of July, 1901, the prescribed illuminating power of the gas supplied by the company shall be *fifteen* candles and the standard price of such gas shall be three shillings and two pence ($0.76) and on and after the first day of July, 1905, the prescribed illuminating power of the gas supplied by the Company shall be *fourteen* candles and the standard price of such gas shall be three shillings and one penny ($0.74), provided, nevertheless, that if the Company shall desire to accelerate the reduction of the said gas hereby authorized from *fifteen* to *fourteen* candles, they shall be at liberty to do so from any first day of January or first day of July, giving three months' notice of their intention to the London County Council."

The Company, on the advice of the Chairman, Sir George Livesey, were not long in availing themselves of the provision to reduce the illuminating power of the gas to fourteen candles. On reference to the Directors' report for the half year ended 30th June, 1901, we find the following paragraph:

"In 1900 the Company obtained an Act authorizing the reduction of the illuminating power of their gas from 16 to 14 candles, with a concurrent reduction of the standard price of one penny per candle. The Act required the Company to reduce to 15 candles from July 1st last and to 14 candles at any time prior to 1905. The Directors, however, thought it better to bring down the standard at once to 14 candles. So far the official daily tests show an average reduction of about 1 candle only. It will take time to work down to the new standard, but the consumers may be informed that it will make no appreciable difference to them in the matter of light."

In the foregoing remarks we have dealt with the legislation of the London Gas Companies; but it must be remembered that in Great Britain almost all Gas Undertakings are incorported under Special Acts of Parliament and that the legislation which we have endeavored to sketch applies also very considerably to provincial undertakings. The general clauses affecting the testing for illuminating power, standard, etc., being followed very closely.

The latest legislation is to be found

in the London Gas Act, 1905, which although not a general act in the sense of the Gas Works Clauses Act, will be taken as a precedent and the clauses included in bills brought before Parliament. The matter is of so much interest that we need make no apology for quoting from the act at some length.

The following clauses are of special interest and importance:

Clause 3. The Gas Referee shall from time to time prescribe the burner for testing the illuminating power of the gas supplied by the company and the chimney (if any) to be used with such burner. The burner so prescribed shall be of such pattern (not being an incandescent or similar burner) as shall be practicable for use by the consumer and the burner and chimney (if any) shall be the most suitable for obtaining, and in making the test shall be so used as to obtain the gas when consumed at the rate of five cubic feet an hour the greatest amount of light.

Clause 4. The gas supplied by the Gas Light & Coke Company shall with respect to the illuminating power be such as to produce when consumed at the rate of five cubic feet an hour in the burner prescribed as hereinbefore provided, a light equal in intensity to sixteen sperm candles of six to the pound and each consuming one hundred and twenty grains an hour.

2. The gas supplied by the South Metropolitan Gas Company and the Commercial Company, respectively, shall with respect to its illuminating power be used to produce when consumed at the rate of five cubic feet an hour, in the burner prescribed as hereinbefore provided, a light equal in intensity to the light produced by fourteen sperm candles of six to the pound, each consuming one hundred and twenty grains an hour.

3. If on any day the gas supplied by the company at any testing place is of less illuminating power to an extent not exceeding one candle than it ought to be, the average of all the testings made at such testing place on that day shall be deemed to represent the illuminating power of the gas on such a day at such testing place.

Clause 5. (1) Each gas examiner shall at such places and in such manner as may be from time to time prescribed by the gas referees, make testings of the gas supplied by the company, for the purpose of ascertaining

(I) The colorific power.

(II) The purity as regards sulphur other than sulphuretted hydrogen.

(III) The illuminating power as ascertained by means of the flat flame burner to be prescribed from time to time by the gas referees which shall be of the best available pattern.

(2) Each gas examiner shall forthwith deliver to the controlling authority to the gas referee to the chief gas examiner and to the company a report of each testing conducted by him under the provisions of this section.

(3) The company shall not be liable to forfeitures in respect of any testings made under the provisions of this section.

(4) The company shall provide and maintain at any testing place such apparatus and materials as the gas referees may from time to time prescribe and certify for use for the purposes of this section and shall give to any gas examiner access to any testing place and shall afford to him all facilities for the proper execution of his duty under this section.

(5) A gas examiner shall make in accordance with this section testings at any place prescribed as hereinbefore provided on such days (exclusive of Sundays) as the controlling authority shall direct.

Clause 6. The gas supplied by the company shall not exhibit any trace of sulphuretted hydrogen when tested in a mode from time to time prescribed and certified by the gas referees for testing and recording the presence of sulphuretted hydrogen, which mode shall not be more stringent than the mode prescribed in Schedule A of the Gas Works Clauses Act, 1871, and Section 15 of the Act of 1880 shall apply accordingly.

Clause 7. After the commencement of this Act the company shall not be liable to any forfeiture by reason of the presence in the gas supplied by the company of impurities other than sulphuretted hydrogen and the gas referees shall not prescribe or certify the amount of sulphur impurities other than sulphuretted hydrogen with which the gas supplied by the company shall be allowed to be charged.

The first practical outcome of this act was the entire revision of the conditions prescribed by the Gas Referees, who in August of last year issued their "Notifications" as to the Standard Lamp to be used for Testing Illumi-

Corporation.	Capital.	Annual Output.	Illum. Pwr.	Selling Price.
Gas Light & Coke Co. (Lon.)	$131,162,633	22,520,083,000	16 c.p.	70c. to 52c.
So. Metropolitan Gas Co......	42,951,450	12,859,712,000	14 "	48c.
Birmingham Corporation	10,477,588	6,908,178,000	16.3 "	60c. to 38c.
Glasgow, Scotland	11,884,806	6,704,891,000	20 "	50c.
Manchester Corporation	5,874,072	5,315,263,000	15.3 "	60c. to 54c.
Liverpool Gas Co............	9,536,475	4,120,444,000	20 "	54c.
Newcastle and Gateshead Gas Co.	13,088,461	3,254,383,000	16.2 "	43c. to 36c.
Commercial Gas Co. (London)	11,157,001	3,224,343,000	14 "	58c.
Leeds Corporation	8,721,883	3,090,155,000	18 "	54c.
Sheffield Gas Co..............	4,503,302	2,936,137,000	17.4 "	40c. to 26c.
Bristol Gas Co................	8,133,427	2,489,000,000	16 "	48c.
Brentford Gas Co. (London)	5,353,428	2,395,413,000	15.4 "	66c.
Bradford Corporation	4,321,401	2,092,868,000	17.5 "	50c. to 44c.
Nottingham Corporation	5,128,897	2,039,571,000	16 "	60c. to 52c.
Edinburgh (Scotland)	5,928,576	1,977,847,000	24.1 "	66c.
Leicester Corporation	5,756,000	1,938,534,000	14.5 "	56c.

nating Power. The time and mode of testing for illuminating power (testing with the Metropolitan Argand Burner No. 2, the present standard). Testing with the standard Flat Flame Burner. Mode of testing for sulphuretted hydrogen. Testing for sulphur compounds other than sulphuretted hydrogen. Mode of testing for colorific power of gas. Testing pressure meters, etc. These revised conditions will be closely followed in the provinces, and the most radical, and at the same time satisfactory circumstance of legislation, is the adoption of Mr. Chas. Carpenter's Metropolitan Argand Burner No. 2. We have so recently called attention to this burner and the "notification" generally that there is no need for any further description.

In order to prove how varying are the conditions under which gas is supplied by gas undertakings in Great Britain and particularly with regard to the standard of illuminating power and the price charged, we give some statistics which will, we feel sure, prove interesting. For some of the figures we are indebted to the very excellent annual publication the "Gas World Analyses of Accounts of Gas Undertakings."

Practical Problems in Illuminating Engineering

Illuminating the Exterior of the Prison Ship Martyrs' Monument, Brooklyn, N. Y.

This problem is doubtless unique in the annals of illuminating engineering, as being probably the first attempt that has ever been made to provide a special means of illuminating a monument regularly with artificial light. The monument in question consists of a single shaft of white granite surmounted by a bronze urn. The monument stands in the center of a plot 222 feet square, as shown by the illustration. The extreme height of the monument from the base is 144 feet. Two different lighting effects were desired: First, the light projected on the shaft of the monument so as to make it stand out distinctly at night; and second, a light on the urn on the top, which should show as a beacon. To secure the first effect, the following means were devised: at the four corners of the square plot in which the monument stands there are to be erected short granite pillars or standards, which do not appear in the general view, but which are shown in detail in Fig. 1. These columns are to be hollow, and have a narrow window, or slot, on the side facing the monument. Within each column an enclosed arc lamp, made to operate in an inverted position, that is, with the regular mechanism below the carbons, is to be placed. The lamp is to be fitted with a special reflector of a form which would be theoretically generated by moving a parabola along a straight line perpendicular to the plane of the curve. Fig. 2. This special reflector will concentrate the rays of light into a thin wedge, the base of which can be made to cover the shaft of the monument. The lamp will be run on direct current, and the natural distribution of intensity will be such as to give a practically uniform illumination on the monument, since the maximum intensity will fall at the top, where it is the greatest

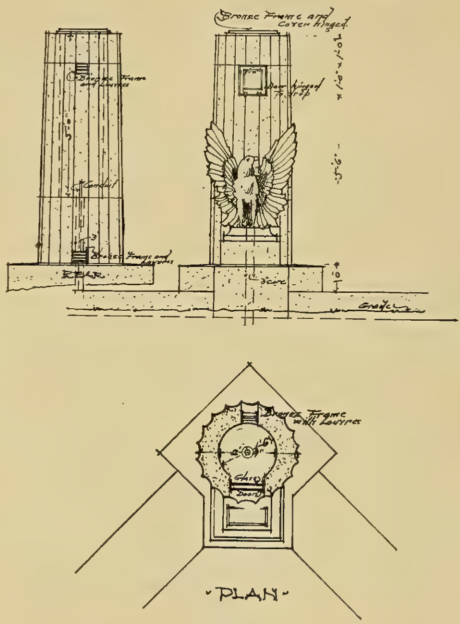


FIG. 1.

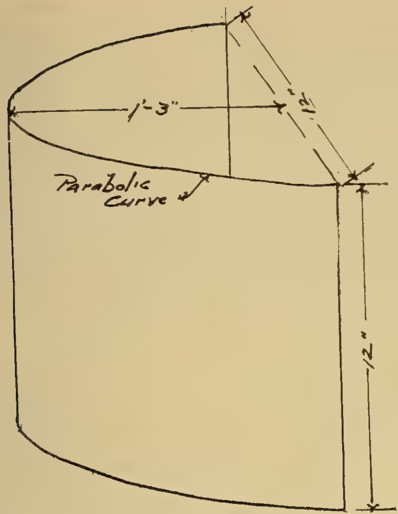


FIG. 2.

distance from the lamp. As four such lamps will be used every part of the surface of the shaft will receive light from two lamps. A bronze torch is placed in the center of the urn, as shown in Fig. 3. The plan of having a jet of steam issue from this torch, the steam to be illuminated by light projected from within the urn, was seriously considered; but the difficulties involved in generating the steam caused the plan to be abandoned. In place of this a gas pipe is lead through the interior of the shaft to the urn, and a burner fitted with an electric igniter is to be placed within the torch so that a gas flame may be made to burn within the torch. Within the body of the urn, which is to be closed on top with a glass plate, are to be located eight 100-c.p. incandescent lamps fitted with parabolic mirror reflectors. By this means a beam, or cone of light will be projected from the top of the urn. Incandescent lamps were used for this purpose owing to the difficulties that would necessarily be encountered in reaching the lamps for trimming or removal.

The general effect of this arrangement will be that of a torch projecting a brightly luminous beam far up into the sky. The general architectural design suggests an ancient light house, with a fire burning on the top, to serve as a beacon, which was a practice that persisted up to within a hundred years ago.

The use of lamps with projecting reflectors, concealed from general view, recalls a case of probably the first use made of this kind of device for interior lighting. Although the installation was quite widely commented on at the time, it will bear repeating here.

The installation referred to is in the general library of Columbia Univer-

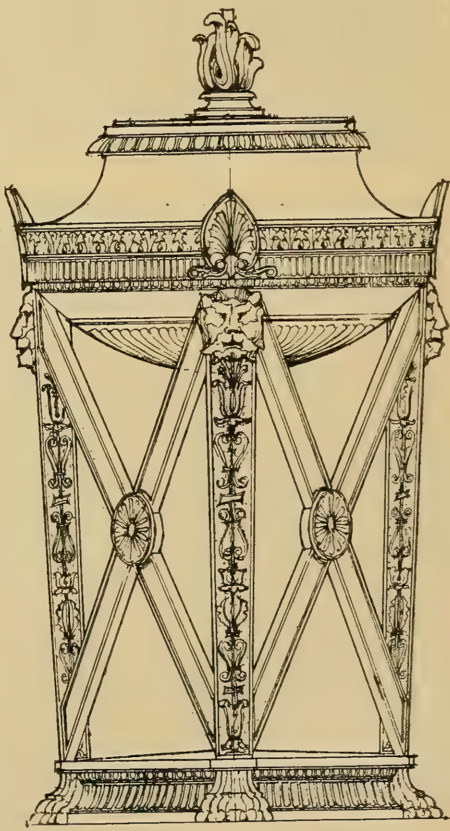
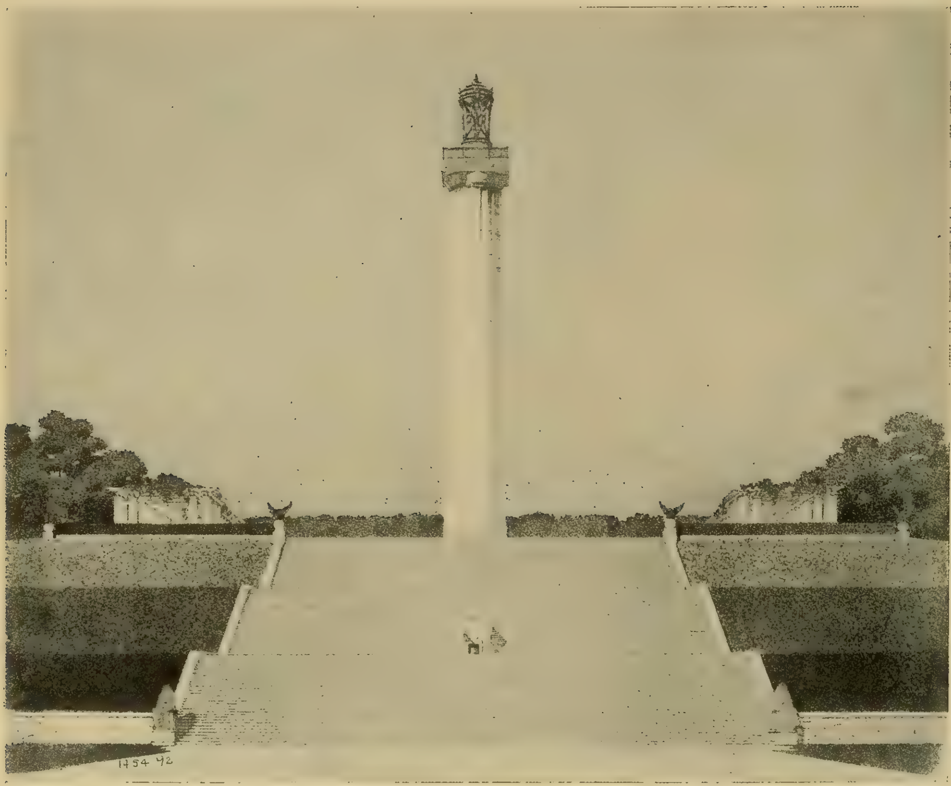


FIG. 3.



PRISON SHIP MARTYRS' MONUMENT, BROOKLYN, NEW YORK.
McKim, Mead & White, Architects

sity. The building is of octagonal form, and is surmounted by a large dome. The general reading room occupies the center of the building. At the center of the dome a large sphere is suspended, which has a "dead," or matt white surface. Eight projecting arc lamps, such as are used for stage lighting, are placed at equal intervals around the base of the dome, the reflectors being so adjusted as to exactly cover the central sphere. This sphere therefore becomes the apparent source of light, and gives a very soft, diffuse radiance throughout the room. Individual reading lamps are of course used on the tables. The total effect is exceedingly pleasant and agreeable to the eyes.

Studies of Notable Instalations

Some Good and Bad Examples of Interior Illumination

It is always a pleasant task to bestow well merited praise, and it has been a pleasure to present to the readers of THE ILLUMINATING ENGINEER illustrated descriptions of a number of lighting installations which were praiseworthy both from the engineering and artistic standpoint. Good and bad are relative terms, and it is quite as instructive to study the mistakes, whether of our own or others' making, as it is to dwell entirely on what is successful. For the purpose of such comparisons the following examples, taken from well-known public institutions in the city of New York, will repay any careful study.

Figure I shows a dining room in an orphan asylum. The size of the room can be fairly estimated from the num-

FIG. I.

FIG. 2.

FIG. 3.

FIG. 4.

ber and position of tables. The illumination is typical of an era in lighting which happily is fast passing away. The single wall brackets, fitted with the familiar fish-tail burner, giving, as the illustration so clearly shows, a sprawling, hissing flame, exemplifies the limit of inefficient and unhygienic illumination. It is apparent from the view shown that the physical well being of the inmates is amply and carefully provided for, with the one important exception of properly guarding against injury to their eyes; and this is undoubtedly an oversight, since the mere substitution of a mantle burner in place of the open flame, fitted with a good diffusing globe, would almost wholly obviate the faults mentioned, by giving a steady and diffused light of ample intensity, and at a less cost than that now furnished.

Fig. 2 shows the interior of a ward in one of the city almshouses. Here an attempt has evidently been made to modernize the illumination. The management can certainly not be ascused of gross extravagance in the means adopted. The familiar drop light, with its flat porcelain reflector, is substituted for the two-light gas bracket. By this simple means the ugliness of the fixture is doubled and the light cut in half. There are few cases in which a single electric lamp could be made to shine directly into the eyes of so many people, with so

FIG. 5.

little chance for escape. The alms house evidently affords a fine opening for illuminating engineers—for which they may in time be thankful, if present conditions continue. Here again the fault is probably oversight rather than intent; the management no doubt considered that they were giving the inmates a distinctly modern improvement in furnishing electric lights instead of gas. A single incandescent gas burner, supplied with a large opal or other diffusing globe, would give a much greater illumination of far better quality, and presumably at a much less cost.

Fig. 3 shows a ward in one of the wealthiest and best-known Metropolitan hospitals. That the building is not strictly modern is shown by the type of fixture used, which is the well-known "combination" gas and electric, a relic of the earlier days of electric lighting, when it was thought necessary to provide gas for emergencies. The electric lamps are pointed directly at the eyes of the patients, so that it is practically impossible to escape their glare without covering the face entirely. This furnishes a species of torture for which there is absolutely no excuse. As before, the only mitigating circumstance is probable oversight on the part of the management; but in an institution expressly devoted to relieving bodily suffering such oversight may properly be classed as criminal negligence. A good flame gas jet burning within the opal globes would be a most welcome relief to the patients. It will be observed that the head nurse has provided herself with an electric lamp and shade which are fairly effective.

Contrasted with this example it is a pleasure to note the view shown in Fig. 4. The lighting here at once stamps the institution as strictly modern; and so it is, being one of the smaller and newer denominational

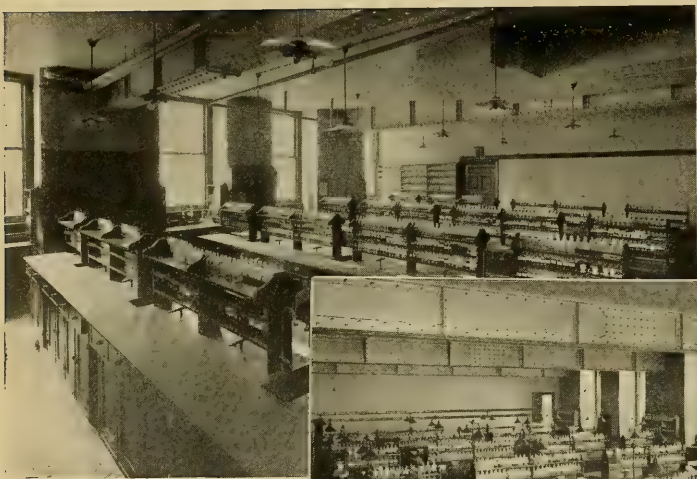


FIG. 6.

FIG. 7.

hospitals of the city. The entire illumination is by reflectors from the white walls and ceiling. The large inverted opal reflector concealing the lamps and reflecting the light to the diffusing ceiling above. Probably no better method of illumination for hospital wards could possibly be devised than the one here shown.

Fig. 5 shows a room for minor operations in one of the old and well-known hospitals. The illumination is quite typical and interesting. It will be noted that the original lighting was by open flame gas burners, without even so much as a pretext for a regular chandelier, ordinary gas piping serving to support the burners. A flame at one of these burners still proclaims its ancient prestige. Later in its history the electric current made its appearance, and in order to make it available wires were distributed about the building in mouldings on ceilings and side walls. The drop-light, carried an unreasonable length from its outlet, hangs unshaded before the operator. From the size of the bulb it is evident that 32 c.p. lamps have been substituted for the original 16 c.p. The side brackets are fitted with the commonest kind of opal shade, of a size and shape entirely unsuited to the larger lamp; while the blackened bulb, which clearly shows in the photograph, completes the picture of the usual lighting system, made absolutely without knowledge or consideration of the simplest principles of illuminating engineering. A few more feet of moulding on the ceiling, and the installation of a modern high candle-power incandescent unit with frosted bulb and reflector, would give a far better illumination than all the devices used, and at less

FIG. 8.

FIG. 9.

than half the electric expenditure of electric current.

Fig. 6 is a view in the chemical laboratory of a well-known medical college. The general construction indicates that the building is modern, but the lighting bears evidence of lack of illuminating engineering skill. The intensity of illumination and the mere efficiency in watts per square foot cannot be criticized, but the large number of bare electric lamps almost directly in the line of vision is to be condemned.

Fig. 7 is a view of another laboratory in the same institution. The lighting here is almost ideal for the purpose. The lamps are so placed as to shade the eyes from the direct rays, while giving ample light on the tables. It is difficult to understand such contrasts in the same insitution.

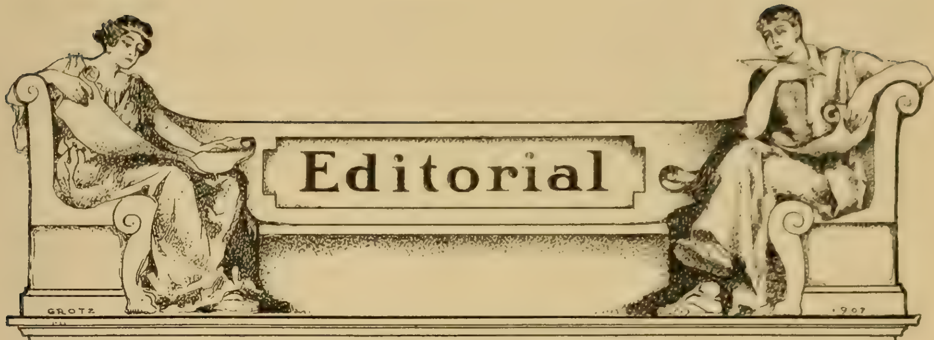
Figs. 8 and 9 are views of microscopic laboratories in two different medical colleges. It will be observed in both these that the daylight illumination is squarely from the front. There may be some such reasons incident to the use of the microscope for this arrangement, but it is not apparent to the uninitiated. It would seem that such an illumination would be bad for viewing opaque objects, since it would require the microscope to be maintained in a vertical position in order to get a good illumination on the object. Illumination from the side would be far easier on the eyes, would

FIG. 10.

give better illumination on opaque objects, and by the use of the substage reflecting mirror, afford equally good illumination for transparent objects. In Fig. 8 the illumination is provided by electric lamps placed on a level with the microscope stage. It is almost inconceivable that the arrangement shown is actually intended for use, as it has all the faults that could well be devised for the purpose intended. Let us hope that the lamps have simply been put in place for the purpose of this photograph only, and that the real intention is to use the sockets as outlets for attaching portable lamps fitted with suitable shades.

Fig. 9 shows a system of lighting a similar laboratory by means of gas, presumably with incandescent burners. The reflectors give a far too limited area of distribution, and within the area lighted expose the unshaded mantle in the worst possible manner.

Fig. 10 is an interesting study in evolution. There is the old open flame equipment, with its trough-shaped opal reflector. Later electricity was evidently introduced, and bare electric lamps were attached to the crossbar. Instead of projecting these lamps well up into the reflector, where they would be well out of the line of vision, and where the reflector would perform its proper function, the lamps have been dropped down where they will catch the eye direct. The "combination" fixture represents a still later development; while the large white reflectors with clusters of lamps well within them are strictly modern. In addition to this motley array, portable lamps are in evidence on the work tables.



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Coöperation

The assembling of representatives from over five hundred companies interested in the production of electric light, from every section of the vast territory comprising the United States, is a striking example of the most important and vital principle underlying modern civilization, namely, coöperation.

It was coöperation that enabled the white man to possess this land and displace the aborigines. The white invaders worked together for a common purpose; the Indians wasted their energies and prowess in combating one another. Next, coöperation produced a nation which has become, within the short span of a century, a giant among the powers of the earth. It was the concerted action of the Colonists for a specific purpose that enabled them to successfully discard foreign allegiance and place themselves forever in the sunshine of national liberty.

In the development of industries the same general evolutionary processes have taken place. Years ago each manufacturing establishment or commercial institution was an independent element, and, like the aboriginal tribe, was either in a death struggle in defence of its own existence, or was waging active warfare upon its neighbors. The fact that such a condition could ultimately result only in disaster more or less to all parties, became more and more apparent as industrial institutions became more powerful, and capable of more savage attack and defence; and so, fearing the fate of the Kilkenny cats, the leaders turned to the principle of coöperation. It was a case, to a large extent, of making a virtue of necessity; but a virtue thus derived is nevertheless a virtue still. The one vitalizing principle which, more than any other, has produced the most remarkable era of commercial prosperity ever experienced in this, or any other country, is comprehended in the word coöperation.

Beginning with the purely selfish purpose of avoiding mutual extermination of the producer or seller, it inevitably engendered hostility on the part of the consumer and buyer; and as the manufactured product is valueless unless purchased by a consumer, coöperation in its broader and truer sense became necessary. This

involves an equitable balance between the producer and user, by which the producer receives fair profits and remuneration for his skill and labor, and the user receives in turn an article of known and substantial merit at a fair price. Price wars being avoided by the coöperation of producers, their sole attention can be given to the arts of peace; namely, improvement in quality and service.

The value of complete and full coöperation has only recently come to be appreciated. The buyer and user is the source of wealth to the producer and distributor; and the highest commercial success, and the most fundamental laws of ethics, alike demand coöperation between all parties. The user of electric light deserves to be taken into the full confidence of the Central Station management, and in return the management deserves the full confidence and support of the user; confidence begets confidence as surely as water seeks its level.

There is no more gratifying indication of the soundness of the progress of modern business methods than just such gatherings as the National Electric Light Association Convention, in which the interests of the consumer are fairly considered as the foundation of PROFITABLE COOPERATION.

The Vacuum Tube Light

The latest word in vacuum tube lighting was given by Mr. D. McFarlan Moore in his paper presented to the American Institute of Electrical Engineers on April 26. The paper was of special importance as giving authoritative information on this method of producing light, and showing the progress that has been made during the past year. As a "report of progress" the paper must be considered satisfactory, both to Mr. Moore and to the public: to Mr. Moore, since it shows that he has taken a number of well defined steps toward the final goal of his ambition; and to the public, as it places, beyond doubt or peradventure, a new luminant at their disposal.

In view of the statement made by Mr. Moore, that he claimed for his system only another luminant adaptable to a certain class of work, the savageness with which his paper was attacked by one of the members taking part in the general discussion is both surprising and regrettable, and can be accounted for only on the general assumption that a man who is about to be hung naturally does not have a very good opinion of ropes. That the vacuum tube light as developed by Mr. Moore has its limitations and faults is freely admitted by Mr. Moore himself; that it also has some extremely desirable qualities not possesed by any other form of light is likewise indisputable, and neither ridicule nor "damning with faint praise" can prevent the recognition of its good qualities by Illuminating Engineers, and the general public.

Perhaps the most interesting point in the paper was the statement made for the first time of the means used to produce white light, which consists simply in the use of carbon dioxide in the tube. The light so produced is for all practical purposes the full equivalent of sunlight, so far as color is concerned. There is a white light tube now in operation in a silk mill, we are informed, the illumination of which is used in assorting and matching colors, and serves the purpose exactly as well as daylight. This feature alone must make the vacuum tube light well nigh indispensable in cases where color value are of paramount importance.

The eye is more sensitive to yellow light than to blue or red, and hence a source producing yellow rays in ex-

cess is of necessity more efficient than one producing the necessary blue and red rays to conform to the conditions of normal daylight. The white light tubes are therefore considerably less efficient than what Mr. Moore calls the "normal" or, "yellow light" tubes. The difference in efficiency is in this case substantially the same as the difference in efficiency of a flaming arc lamp giving the so-called white light, and the lamp giving the ordinary yellow light.

There is one property of the Moore light which deserves especial investigation, since the precise nature of the effects are not at present well understood, and that is the flicker produced by the successive connective discharges. On the lower frequencies this flicker is plainly perceptible with moving objects. The higher the frequency the less the visual effect of flicker; but there seems to be electrical difficulties in the use of the very high frequencies. An interesting point in regard to this is also the question as to whether electrical waves outside the visual range may be set up, which will have an effect either upon the organs of vision, or even upon other organs of the body. From the progress made in the past year there is good reason to believe that Mr. Moore will in time be able to eliminate this undesirable feature.

Mr. Moore deserves the highest praise for having taken up an investigation in which he had only theoretical possibilities for encouragement, and in which previous investigators had achieved so few results that scientific wiseacres considered him a mere rainbow-chaser to attempt. In at last giving to the world a practical and valuable method of securing light from incandescent gases Mr. Moore has dealt another well-deserved blow to the "can't-be-done" fraternity of scientists and manufacturers. To the patient and enthusiastic investigator or inventor there is really but one thing that may be safely put down in the "can't-be-done" class, and that is to convince the man who believes that the only way to carry grist to the mill is by putting a stone in one end of the bag, because his father and grandfather did so, that there may possibly be a better way. And it is worth remarking in this connection, that the great discoveries in science, and inventions in mechanics, have largely been made by "greenhorns," who were so ignorant of the conditions surrounding their task, that they did not even know that it could not be done. The "wild-eyed inventor" and scientist has often times proven that he saw clearer and farther than his detractor, and has in the end materially aided in the world's progress, while the "can't-be-done" individual has never been known to accomplish anything, except his own confusion.

Mr. Moore has added substantially to scientific and commercial progress. "Honor to whom honor is due."

Candle-Power as a Basis for Selling Gas

In another section of this issue will be found a summary of the requirements and provisions for testing gas in England, as prescribed by law. Since gas holds a relatively much stronger position as a luminant in England than in this country, the general statutory regulations and the practise of the English Gas Companies are matters well worth considering by American Engineers.

The fact which will first impress the illuminating engineer in going over these statistics is the comparatively low candle-power required by law; in no case does this exceed 16, and in some important cases only 14 is required. The next fact that will create

even more astonishment, is the low price at which gas is sold. The lower candle-power requirements of course account for the lower price to some extent, while lower labor cost, and other economic conditions, must account for the balance; but these belong rather to gas engineering than to illuminating engineering, and hence need not be further discussed here.

The question of candle-power as a rating of gas at once brings up the question, "Why use candle power at all?" There is absolutely no excuse at the present time for using gas flames for the production of light. Incandescent burners have been so cheapened in price, and improved in quality, that they are well within the reach of every one. The mantles have undergone an equal improvement in quality, and reduction in price, with every prospect of still further improvement, especially as regards the facility with which they may be handled. All expense occasioned by the addition to the gas of material necessary to produce luminous flames is therefore sheer extravagance.

The only scientific and logical basis of determining the quality of gas for modern use is its calorific power. On this basis alone it is altogether probable that gas could be made and delivered in this country at prices no higher than those now prevailing in England. The material reduction in the price of gas to the consumer would not only give it a new lease of life as a luminant, in competition with the electric light, which will certainly be greatly reduced in cost within the next few years, but would enormously increase its use for fuel and power purposes. The ultimate profits to the producer would therefore be increased by such a procedure, while the benefits to the public would go far toward allaying the feeling of distrust, amounting frequently to actual hostility, that now so commonly prevails.

Illuminating gas, that is, gas which will burn with a luminous flame, is as unnecessary in the present state of Illuminating Engineering as whale oil and "camphene." The sooner candle power is disregarded in favor of calorific power as a basis for the commercial rating of gas the better for all concerned.

The Value of Illuminometry

We have ventured to coin a new word for which there seems to be an actual need in the nomenclature of Illuminating Engineering. Though all do not yet agree as to the necessity or propriety of distinguishing by a separate name a photometer especially constructed for the purpose of measuring illumination, we believe that the term illuminometer, as applied to such instruments, will aid materially in emphasizing the distinction between light and illumination, and therefore become a valuable acquisition to the terminology of the science. Having an illuminometer, then, the theory and practice of its use constitutes the subject for Illuminometry.

The first step towards the science of illuminating engineering was taken when the photometer was invented; for no knowledge can lay claim to the name of science in which quantitative measurements are not the basis. The construction of an illuminometer comparable in simplicity of construction, accuracy of results, and ease of comprehension, to the best modern forms of photometer, will constitute the second epoch in the evolution of illuminating engineering as a science. The calls for such an instrument have come with increasing stress since illuminating engineering has become a practical and recognized profession; and al-

though there have been laboratory instruments of this kind for a number of years, a small portable apparatus, which can be operated by the layman as well as the professional, has been sadly wanting until recently. At the present time there are several instruments, either actually on the market, or of which working models have been constructed, that fulfil these conditions, reasonably well, and the air is full of rumors of others still to come.

The one obstacle heretofore in the production of such an instrument has been to secure a standard light-source which would meet all the requirements. The development of the metallic filament incandescent electric lamp has solved this difficulty. Lamps of this type can be made to run on exceedingly low voltages, say four to five, and can, therefore, be operated from a small storage battery. The candle-power of such lamps of course needs to be very small. It is thus possible to secure a standard light-source operating under practically the same conditions, and, therefore, having all the accuracy, which is secured by the use of the large storage battery outfits and carbon filament lamps, which have made laboratory photometry a comparatively exact science. All the different methods of comparison used in the ordinary photometer are adaptable to the illuminometer. There is no reason, therefore, why measurements of illumination should not be made with very nearly the same degree of accuracy as attaches to photometric measurements. When it is remembered that the entire product of the gas factories and the incandescent electric lamp manufacturers is sold on a basis determined by photometric measurement, the importance of illuminometry in the production and sale of luminants becomes apparent.

In view of the foregoing facts and comments, a certain editorial discussion in a recent number of an electrical journal, will bear investigation. In Mr. Moore's paper before the American Institute of Electrical Engineers, he laid particular stress upon the value of measurements of illumination as indicating the actual efficiency of light-sources. The results of measurements of this kind which he gave showed very favorably for the vacuum tube light, which leads the journal in question to ask "by what sort of hocus-pocus these results were obtained," and to conclude with the comment that "if they represent the actual values obtained by the use of an illuminometer, so much the worse for the illuminometer." The plain inference from these remarks is, that either the values obtained were "fixed" for the purpose, or that an illuminometer is a wholly untrustworthy instrument. We do not believe that any scientist or engineer at all conversant with Mr. Moore's long and painstaking experimental work will consider the former possibility for a moment. As to the unreliability of illuminometer measurements, we can see no sufficient reason for any such sweeping denunciation. The principles upon which the illuminometer is constructed are essentially identical with those upon which photometers depend—in fact, it is for this reason that some objection is made to distinguishing an illuminometer from a photometer—and to condemn an instrument because the results obtained do not accord with preconceived notions as to what results ought to be obtained, is an application of the spirit of the dark ages rather than of twentieth century enlightenment.

Correspondence

From Our London Correspondent

The purchase of incandescent mantles has now become a matter of everyday experience with Illuminating Engineers, and the Inspectors, who are appointed in this country by the Lighting Authority, are often sadly taken in by the plausibility of the commercial traveler, or as he is known in America, the "drummer" of trading firms. It will therefore not be out of place to deal with one or two simple conditions which should be made. We are quoting from the actual system adopted by the Chief Lighting Inspector of a corporation which owns the gas works and controls the gas lighting of a large city in Great Britain. He has found it necessary to specify a uniform length, diameter, and weight. In an article contributed to one of the leading papers devoted to gas matters here, he said that far too little reliance is placed upon the matter of weight. Assuming that the mantles are made from the well-known Welsbach formula, viz.: 99 parts of thoria to 1 part of ceria, it must be granted that their ultimate value as lighting agents will depend largely upon the amount of ash each mantle contains. The lighter the ash the cheaper the mantle; and as a consequence, the shorter its life. There is, he said, little risk of the manufacturer loading his ash with deleterious substances, on account of the very serious loss of light that would ensue; on the other hand, there is nothing to prevent the squeezing of the impregnated stocking in his desire to under-cut his competitor.

The writer stated that in one particular winter month his mantle bill went up from the usual average of 0.9 to 1.9 mantles per burner. The mantles were bought at a fair average price, and supplied by one firm. The mantles were of German manufacture and delivered in sufficient quantities to meet the demand for six weeks winter consumption.

In order to seek out the cause, a series of eight mantles, supplied by as many different firms, were subjected to a simple test. Half a dozen of each make were taken from stock, measured for length and diameter, weighed, burnt off, the asbestos loops carefully detached from the ash, and the remaining ash carefully weighed. The results are given in the following table:

Size A. Make.	Weight in grains.	Size B. Make.	Weight in grains.
German.....	5.5	German.....	6.79
British......	6.76	British......	8.08
"	7.22	German.....	8.11
"	7.51	British......	10.37

The mantles which were used during the period when the bill went up were those "made in Germany," of the A size, weighing 5.5 grains. He tells us that the price of these mantles was practically the same as that given for

the British made mantle of the same size weighing 7.51 grains; this latter mantle gave better light and has a longer life.

The German mantle, size B, weighing 8.11 grains, or rather more than the British 8.08 grains, was bought at a specially high price, but it was found that the price was not warranted by the actual working results obtained.

There would appear to be one point upon which the German manufacturer scores; he turns out mantles which vary very little in their weights, as will be seen in the table. The mantles tested were taken indiscriminately from stock. The results obtained from British manufactured mantles are also given.

Make.	Difference between maximum and minimum.
British	0.46 grains
German	0.62 "
"	0.78 "
"	0.86 "
British	1.03 "
"	1.53 "
"	2.27 "
"	3.00 "
"	3.12 "

It is really extraordinary to find, in an article weighing on an average about 10 grains, that there should be in the British-made mantle a variation of 3.12 grains. This is against the British manufacturer who fails so often to standardize weights, quantities and dimensions.

One other test given is of interest, and that is the stretching test, which consists in attaching an "ashed" mantle to one end of a balance, the bottom of the mantle being held firmly in a weighted block of paraffin wax, the other end of the balance being then loaded gradually until the ash tears away. Under this test six different makes of mantles, all of the same size, gave the following results:

Make.	Result.	Weight applied.
British	Broke at neck	501 grains
"	" " "	423 "
German	" " base	285 "
"	" " "	224 "
British	" " neck	178 "
"	" " "	101 "

For some years Mr. Garcke has issued "The Manual of Electrical Undertakings," and it is interesting to note the increase of the industry. Taking a period of four years, we find that in 1904 there were 187 companies operating electricity works, with a capital of £10,000,000 ($48,000,000), in 1907 the number had increased to 206, and the capital to £31,870,000 ($153,076,000). Municipalities owning works in 1904 were 254, with a loan capital of £35,720,000 ($171,450,000), and in 1907, 268, with a capital of £37,470,000 ($179,756,000). It will be noted that with us the industry is largely in the hands of the municipal authorities. The general development in the growth of electricity supply is shown by the following table of units sold by both undertakings.

Year.	Number of undertakings.	Number of units sold.
1904	356	344,512,636
1905	380	448,078,057
1906	405	533,594,315
1907	418	712,699,534

By far the greater field for electrical progress is in the rapid extension of electric traction, with which, however, we have no especial interest, but we might mention that to-day the capital invested in that industry is not less than £120,000,000 ($576,000,000).

The inverted burner lamp which we illustrate (Fig. 1), the invention of Moritz Praskaner, has some novel points; the air admitted to the Bunsen tube is pre-heated, and is led in through cross tubes to the lower end of a casing which surrounds the tube; its travel up through the casing to the

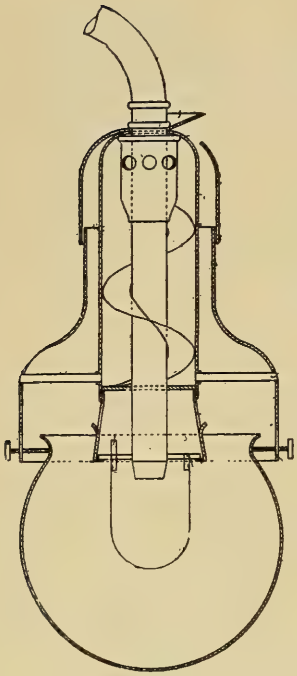


FIG. I.

air holes of the Bunsen tube is lengthened by means of a spiral. The products of combustion pass up through a jacket surrounding the air-heating chambers. The upper part of this jacket is adjustable so that the outlet opening for the products of combustion can be placed at any side of the lamp desired. On the other hand the products of combustion which are caught in the lower funnel escape into the jacket through openings provided for the purpose.

The following paragraph appeared in a recent issue of the *Electrical Review,* a publication which, as will be seen, has no bias in favor of illuminating gas; it says: "An interesting light upon the straits to which the gas industry is put in its endeavors to compete with electricity is thrown out by a German patent recently taken out by a Frenchman, Mr. Emile Louis Andre, of Arcachon. The patent covers the use of an egg shell as an incandescent mantle. The egg is to be blown and to have its two ends cut off, and then it is to be supported round a gas burner, more particularly a burner consuming acetylene gas, so that it may be heated to incandescence from the inside. The inventor, of course, claims that the light is very pleasant, and that the mantle does not exhibit the absurd amount of fragibility characterizing the products made according to the Welsbach patent. The writer continues "We can well believe this second claim at any rate."

Notwithstanding the cheap sarcasm of the writer of the preceding paragraph, the adoption of the incandescent gas burner for public lighting is extending by leaps and bounds, and will soon be universal.

We have just received intelligence that the Belfast Gas Committee, acting upon the report of their engineer, Mr. Robt. Sharpe, have decided to convert the whole of the public lighting from flat flame to incandescent burners, to spread the work over a period of five years, at a cost of £10,000 ($48,000). Mr. Sharpe advised a lamp suitable alike for vertical or inverted burners, and suggested that they could be made in their own workshops (the gas undertaking is the property of the municipality) at the rate of one hundred a week. With regard to the question of converting existing lanterns, the cost would be about 10s. 1d. ($2.42) per lamp and it is estimated that the cost of "rebuilding" the lanterns would be 14s. 4d. ($3.44). That being the case, Mr. Sharpe advised the installation of new lamps throughout the city.

Some interest is being taken in the rather sudden advance in the price of thorium nitrate, from 27 marks (about $6.50) per kilogramme, to 35 marks ($8.40). The additional cost of this chemical used in the manufacture of

incandescent gas mantles, if sustained, would mean an additional cost per mantle of about one cent. But the price of thorium has been subjected to great fluctuations since its discovery thirteen years ago; the price was then 2,000 marks ($480) per kilo, in nine months it fell to 300 marks ($72). In February, 1906, the price stood at 53 marks ($12.72), but since that date there have been large finds of monozite sand from which thorium is extracted, and there is little likelihood of thorium being again sold at a high price.

It will be remembered that we contributed a somewhat exhaustive article on the "Scott-Snell System of Self-Intensified Gas Lighting," to the September number of THE ILLUMINATING ENGINEER, and it will doubtless be of interest to many if we give a short notice of a recent invention of Mr. Scott-Snell's for "Pressure Raising for Incandescent Gas Lighting by Means of a Steam Injector." The steam generator is heated by a small gas burner, and is directly connected to an elevated water supply. By reason of the direct connection to the water supply the admission of water ceases as soon as the steam pressure is equivalent to the predetermined water pressure, and any immediate surplus of steam relieves itself by entering and condensing in the water supply. The injector employed is shown in Figs. 2 and 3. Steam enters

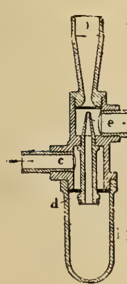


Fig. 2

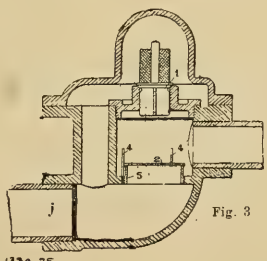


Fig. 3

at *c*, passes through wire gauge, or other straining material, *d*, and thence to the injector nozzle *e*. Steam free from solid matter is thus obtained, and all tendency to choke the nozzle is avoided. The steam jet sucks, or draws in, gas from the service, *j*, and the steam is subsequently condensed in an air cooled condenser, leaving the dry gas to pass to the burners. In order to provide more uniform regulation and to obviate violent fluctuations of steam pressure, there is interposed between the water supply and the steam generator a valve opening towards the water supply, and a by-pass. This by-pass is capable of regulation, and is so designed as to allow only a very slow feed to the generator, while a quick return from the generator to the supply can take place through the valve. If it be desired, the inlet valve may be in connection with the full controlling valve, to a certain extent also controlling the consumption of fuel (supplied by the flame from the small burner.) In order to avoid excessive pressure of gas in the lighting system, the high pressure gas service *g*, Fig. 3, is joined up to the low pressure service *j*, through a check valve *i*, so weighted as to allow the gas to return to the low pressure service if an abnormal increase of pressure occurs. A valve 2, opening from the low pressure to the high pressure service is also provided to prevent the latter becoming denuded of gas in the event of stoppage of the pressure raising apparatus. Such a valve must, of course, be very light and may be constructed of a thin glass or aluminum disc working in guide pins 4, over a special seating 5. Mr. Scott-Snell in his specification says: "I find that with my apparatus the water supply, and therefore the steam pressure generated, being at 50 lbs pressure, it re-

Company.	Average ill. power in standard sperm candles. Argand burner.	Flat-flame burner.	Calorific power in calories.	Sulphur in 100 cubic feet. Average in grains.	Sulphuretted hydrogen.
Gas Light & Coke Company (15 stations)	16.61	11.88	132.5	39.9	Absent
South Metropolitan Gas Company (6 stations)	16.84	11.14	134.2	46.5	Absent
Commercial Gas Company (2 stations)	15.45	9.45	127.8	35.1	Absent

quires about 6 lbs. of steam to be used in the injector per hour, to effect the compression of 1,000 cubic feet of gas per hour, from 2 inches of water to ten. This gas will be sufficient to operate 100 burners of 10 feet each and thus produce a light collectively of about 35,000 candle power at the mantles. I find that convenient dimensions, in one form of my apparatus, are about 18 inches for height of the outer tube of the boiler, and about 4 inches inside diameter, a properly working air condenser for this consisting in from five to seven chambers or turns, each about 4 feet long by ¼ inch wide by 12 inches deep, separated by 1 inch air spaces, and arranged sufficiently above the floor to allow free entrances of air between the turns." Mr. Scott-Snell has carried his invention to a practical issue, and the system and apparatus described are in operation commercially.

Quite recently we referred at some length to gas testing in London, and particularly to the conditions that govern such testings. Dr. Frank Clowes, chief consulting chemist and head of the special department, having charge of the testing of gas for the London County Council, has issued his report, giving average tests for twelve weeks. The tests were made in accordance with the Gas Referees "Notification" (fully dealt with by us some time back) and with the Metropolitan No. 2 Argand burner. It would not be of interest to give the averages at the twenty-three testing stations within the jurisdiction of the London County Council, but we summarize in the accompanying table the average over the whole areas supplied by the three Gas Companies responsible to the Council.

The standard of illuminating power of the gas supplied by the Gas Light & Coke Company is 16 sperm candles, the South Metropolitan Gas Company and the Commercial Gas Company 14 sperm candles. It will be noted that the companies have all more than maintained the statutory standard of illuminating power. Commenting upon this report, the *Journal of Gas Lighting* said: "The Gas Light & Coke Company have maintained the illuminating power of their gas with narrower margin from their 16 candle power standard than have the South Metropolitan and the Commercial Companies with their 14 candle gas. The excess illuminating power in the case of the latter companies is perhaps due to the inability in the one case to get closer at present (making coal gas only) to the 14 candle standard, and in the other, an absence of desire to at present attain to closer working to their standard." The Gas Light & Coke Company and the Commercial Company both send out carburetted water gas with their coal gas, but the South Metropolitan sends out only "straight" coal gas.

It is not, of course, to be expected that this last mentioned company will continue to supply its consumers with gas of an illuminating power two candles in excess of that fixed by act of Parliament.

CHAS. W. HASTINGS.

Lighting the "Great White Way"

From the New York Times.

They were looking out from a high window on the glare that makes Broadway "the White Way." The woman saw it all for the first time. Although not ordinarily commercial, the spelling out of the diverse electric commands to drink this and eat that, to dine here and to sup there, made her reflective in a spirit that wasn't entirely alien to that which our foreign critics have attributed to America.

"I wonder what its value is?" she said.

"In dollars and cents?" he asked?

"Yes," she answered, "but of course you could not calculate that, since it is all a part of a system that does not hope to derive a definite profit from each sign—that is, the people who advertise in this way do not expect that you will really drink the stuff after you read the sign. What they seem to me to aim at is just this: They wish to make the name of their product as nearly standard as possible, so that when you think of that particular drink you will think at once of their electric scream. With the large number of makers who are advertising thus extensively, of course the attaining of any such condition is merely the ideal. However, one can say that with many of the older products that were developed years ago this condition has been reached.

"So if you could figure the dollars and cents that came into the pockets of any concern as the result of its whole system of advertising—of making partially or wholly the name of its product standard—you might be able to ascertain a certain sort of figure for each sign by dividing the total by the number of signs. But of course this figure would in the end represent a sort of systematized guess."

The subject seemed to interest him. He took it up thus:

"It is quite certain that the total amount of publicity that is secured here in New York by these electric signs is tremendous. People come here from all parts of the country in each one of the seasons—each season having its class of visitors who have particular reasons for coming at just that time of year."

"Yes," she agreed, "the total publicity secured by the signs here in Manhattan is considerable."

"Yet it is gained," he continued, "at a comparatively slight cost per night."

"Is it possible to figure that?" she asked.

"I had some figures," he said, "that I secured recently for a purpose that are decidedly interesting. I got them right from the headquarters of the largest electric light and power concern in the city. They did not want at first to give them, as they said that they could arrive at only an estimate, that they wouldn't want to state officially. But do you know how much that glare, all of it—that is, the outside signs and outside lights of Broadway from Twenty-third to Forty-second street—costs a night?"

"How much?"

"Only $200 a night. And think of the different kinds of glow that are supplied for that sum. There are all sorts of electric signs that have a mechanism for changing the color of the wording or spelling out different words. In the last case they are a sort of circular, or rotary, machine, which, like the other devices, is operated by a small electric motor, supplied from the same source of electric energy that manifests itself in the brilliant lights. Then there is the flaming arc lamp which gives that peculiar purple glow in front of some theaters. This is an arc light so arranged that the carbons are consumed and have to be replaced daily. Then there is a German lamp, which is raised to its initial state of the heat requisite for the giving off of light by a small heating coil, which is cut off automatically after the light is started. Then there is also the mercury vapor lamp, which some of the

stores have before their doors. And its total cost is $200 a night."

"How much does it cost to light the whole of Manhattan for a night?" she asked.

"Fifty thousand dollars," he said, "covers the cost of all the electricity consumed in Manhattan in a single night for lighting purposes, though the cost of the city lighting in the streets alone is but $1,250 a night."

She reflected a moment. Then she asked:

"I wonder what the lights in the theater where we were to-night cost—that is, aside from those that were thrown upon the poor heroine, who didn't have any dinner dress from other sources?"

"The lighting—that is, the electric lighting—of a theater is not an important sum. In fact, it is only about $20 a night, while one of the Broadway hotels spends only about $15 a night."

"I wonder how many of those little throbbing electric globes there are in the city?" the girl said.

"I have the figures on the first of March," he returned. "Then there were 2,504,694 incandescent lights and 33,227 arc lights, though, of course, they are never all going at once."

He was reading from a small note-book now.

"On that date, too, there were being delivered 143,845 horse-power to motors, representing an equivalent of 4,883,607 incandescent lamps of sixteen candle-power."

The girl put the subject away from her as though the figures had confused her.

The Magnitude of the Gas Industry

Some idea of the size of this industry may be obtained when it is stated that in 1905 the total value of the raw materials used was $37,180,066. It is interesting to see how the materials are distributed. First we have the item of coal, 4,431,774 tons, costing $14,607,485; next we have 403,263,738 gallons of oil, which cost about the same, the sum being $14,531,585. Coke is a smaller item, 435,534 tons, costing $6,176,340. Vast quantities of water are required, no less than 5,430,361,158 gallons being used. Fortunately, water is not very expensive, $253,895 representing its actual cost. Other materials amount to $6,176,340.

Our total cost was $37,180,066. Now, what is the value of the product? The hand of man—the chemist co-operating with nature by the use of the materials of her mineral kingdom—has succeeded in making a subtile aeriform mobile product, valued at $112,662,568 and occupying the enormous bulk of 112,486,783,148 cubic feet.

The product is divided both as to kind and value as follows:

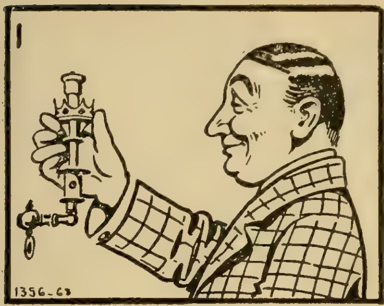
	Cubic feet.	Value.
Straight coal gas	12,674,033,691	$12,868,604
Straight water gas.	715,550,006	832,440
Carbureted water gas	54,687,118,030	48,071,180
Mixed coke and water gas	40,980,413,950	45,605,263
Oil gas	3,397,456,873	5,141,460
Acetylene gas ..	7,880,666	104,267
All other gas....	24,329,932	39,354

Not only do we have these valuable gases, but we have by-products as well. Coke, valued at $5,195,461, represents 89,146,434 bushels; while $2,064,343 stands for the value of 67,515,421 gallons of tar. All other products are worth $972,992. A considerable revenue is derived from rents and sales of lamps and other appliances, such as stoves, the amount of this business being $4,249,381.

Comparison of raw materials and the product are always interesting, and especially so in the case of gas, where a graphical representation becomes positively spectacular. The total amount of gas of all kinds produced in the United States for 1905 would fill a gasometer 5,829 feet in diameter and 4,556 feet high. Assuming that a gas engine consumes 92 cubic feet of gas per hour, being the mean between a minimum consumption of 70 and a maximum of 115 feet per hour (Mathot's figures) this quantity of gas would run gas engines having an aggregate of 407,560 horse-power 10 hours a day for 300 days. According to the Twelfth Census, there were 14,884 gas engines, which furnished 143,850 horse-power, a pitiful percentage of 1.3 of the total horse-power. Since this enumeration the number of gas engines in use has been materially increased; but even so, the great bulk of gas is used for illuminating and heating purposes.

HOW TO FIX A GAS MANTLE

[*Verbatim copy of printed instructions with appropriate quotations.*]
From *The Electrical Times.*



ACT I. Important, do not pinch head of mantle between finger and thumb. Remove burner head.

Why should we anticipate our sorrows?
It is like those
Who die for fear of death. —DENHAM.

ACT II. Fit fork.

Things done well,
And with a care, exempt themselves from fear.
Things done without example, in their issue
Are to be feared.—HENRY VIII.

ACT III. Hold mantle in palm of hand, pass mantle gently over burner head until fork catches up the loop. Be careful that fork does not pierce mantle.

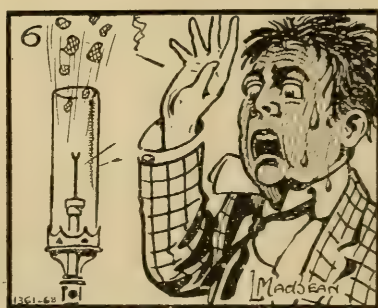
The secret of success is constancy to purpose and patience is a necessary ingredient of genius.
—DISRAELI.

ACT IV. Fit chimney before burning off mantle.

Man is not the creature of circumstances. Circumstances are the creature of men.—DISRAELI.

ACT V. Replace burner head on Bunsen tube, and before turning on gas, light mantle from skirt and burn off toughening.

Do not, for one repulse, forego the purpose
That you resolved to effect.—THE TEMPEST



ACT VI. Turn gas half on and hold light over chimney til gas ignites. Then turn gas full on, the lamp being ready for use. Bunsen tube should be blown through periodically to remove dust.

Whip me, ye devils,
Blow me about in winds, roast me in sulphur;
Wash me in steep-down gulfs of liquid fire.
—OTHELLO.

The Illuminating Engineering Society

Meeting of the Chicago Section, May 9th

Industrial Plant Illumination

By George C. Keech.

The artificial illumination of industrial plants is of the greatest importance, as it must be depended upon for from ten to twenty per cent. of the working hours of average plants not running nights or overtime.

Where every successful operation is a source of profit and every error a loss to both employer and employee, the artificial illumination should be sufficient and lamps properly placed so that work can be done as well as by daylight.

It is strange to compare the clean windows and bright and well-shaded lights in a factory office covering the clerical force, with the dirty windows and oily or dusty lamps which are used by the real producers.

There are few plants which make a

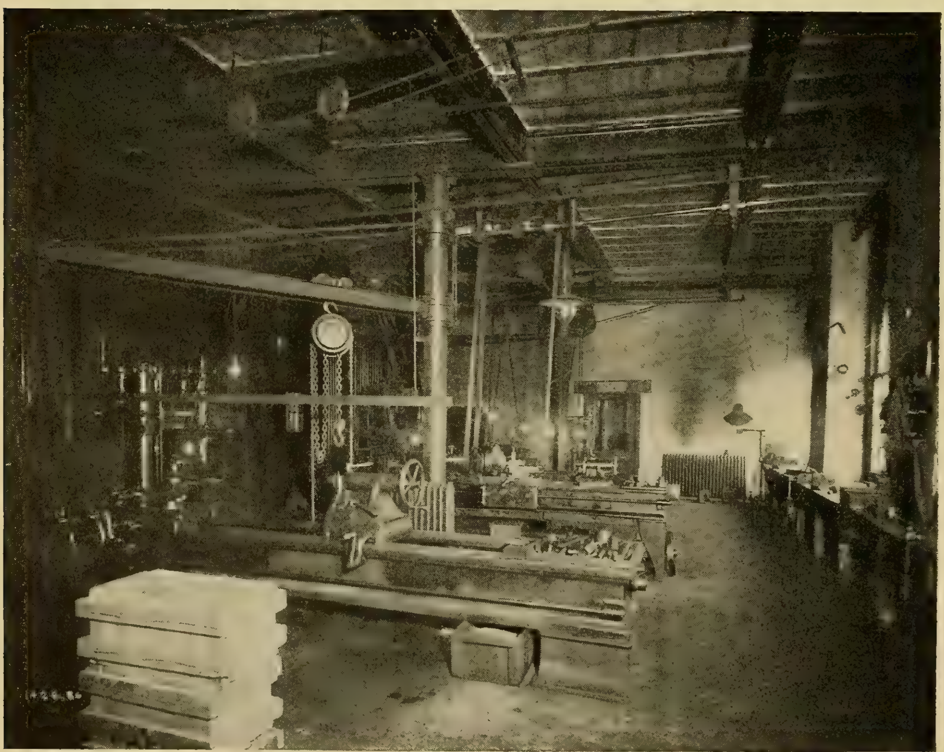


FIG. I.

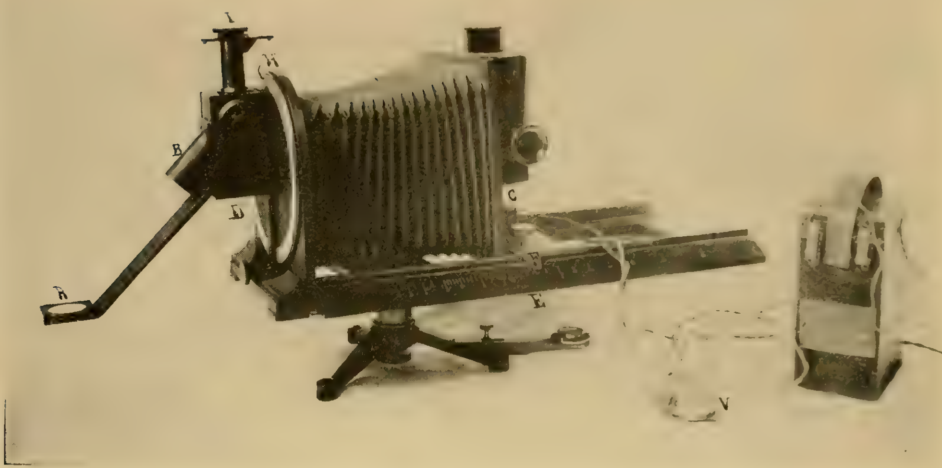


FIG. 2.

practice of cleaning and renewing incandescent lamps, and the attention given to arc lamps would be less if regular trimming were not necessary.

Dull tools are not tolerated in manufacturing institutions, why should dull lights be?

I have a very positive statement of a

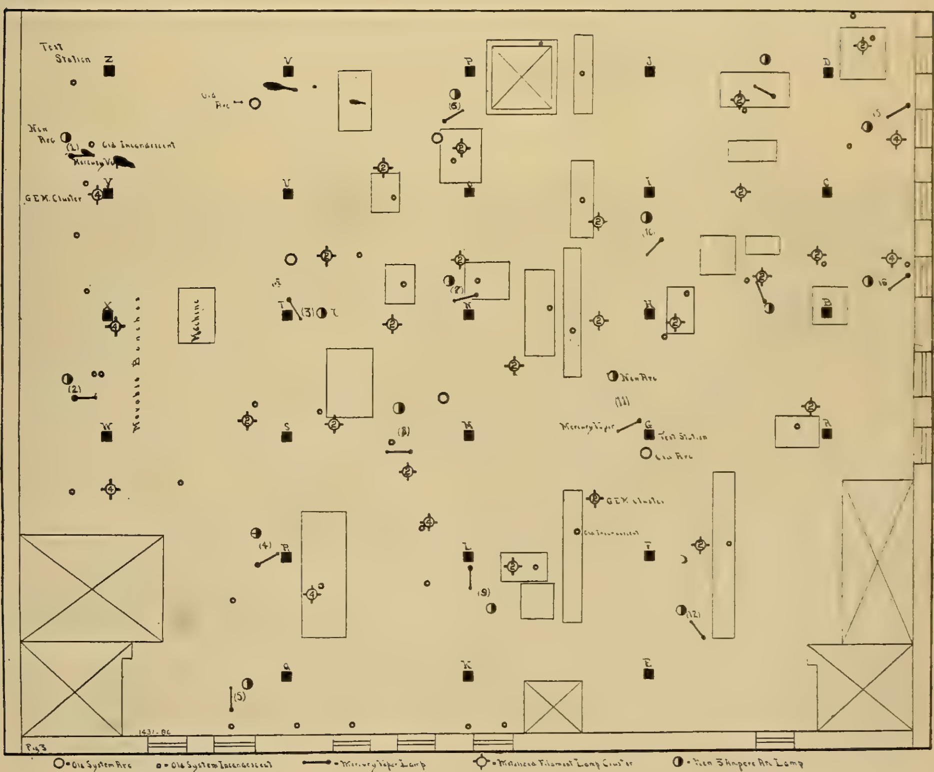


FIG. 3.

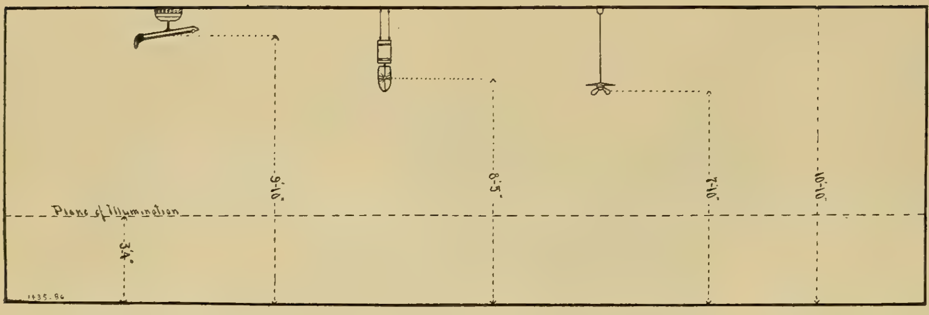


FIG. 4.

foreman to the effect that the product of his department, operating during night hours, was increased about fifteen per cent. by a thorough overhauling of his shop lighting. Even a smaller percentage of increase would justify most plants in giving the matter of their illumination more attention.

It is common practice, together with some large units for general illumination, to furnish each workman with a single 16 candle-power incandescent lamp which, when new and at the average height from his work, usually gives him a fair amount of light. Dirt, oil, sawdust, etc., soon reduces his illumination one-half, but it is not expected that the quality or quantity of his work should be reduced in the same proportion.

Figure 1 illustrates this kind of illumination with the very common but bad system of bare, clear incandescents over each piece of work.

The lamp at the drill press near the left of the picture hangs 1 foot 1 inch above the face plate and 7 inches from the center at which point it gave 3.7 foot candles. (The amount of light entering the eye of the workman was not measured.)

A new, clean lamp was placed in the same socket and gave 5.6 foot candles at the same spot. Again, the dirtiest lamp in the shop was substituted and measured only 1.55 foot candles.

These lamps with even the cheapest shades or reflectors would produce better results and catch less dirt.

The illuminometer with which the foregoing tests were made is a Weber type shown in Figure 2. The standard is a

FIG. 5.

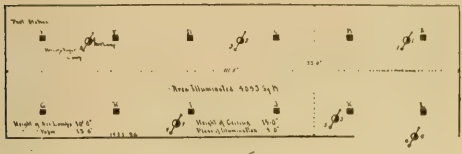


FIG. 6.

low candle-power tantalum battery lamp carefully calibrated before each test and operated at the proper voltage during the test.

The disk (A) receives the illumination which enters the screen through the tube (B). The standard at (C) is moved back and forth with respect to the screen (D) until the spots merge as observed through the eye-piece (I) and the graduated scale (E) reads directly in foot candles as indicated by the pointer (F).

Figure 3 shows a layout of woodworking machinery in a Chicago factory with four different systems of lighting, as indicated by the key. The floor is 75 feet by 97 feet, and the net area after deducting stairways, etc., is 7,044 square feet. This floor was originally lighted by five 5-ampere arc lamps and forty-five 16 candle-power individual incandescents. No test of this system was made and it was fairly satisfactory, although the energy was high as will be noted in the following table.

TABLE 1.

AVERAGE FOOT CANDLE READINGS OF 26 STATIONS.

Station.	Mercury Vapor Lamps.	Metalized Filament Clusters.	Arc Lamps.
A	.35	.85	.35
B	4.47	1.11	4.39
C	2.35	1.32	2.06
D	3.51	.72	5.28
E	1.48	1.09	1.63
F	1.48	.70	1.42
G	3.25	4.20	1.92
H	3.00	1.58	1.50
I	3.00	.50	7.30
J	.79	.29	.47
K	.70	.16	1.22
L	3.45	2.57	1.75
M	2.60	1.07	2.78
N	6.20	1.76	1.96
O	2.48	1.65	3.80
P	2.17	2.62	.75
Q	3.80	.40	2.76
R	9.42	1.73	5.02
S	1.62	1.88	1.92
T	5.37	1.73	5.03
U	.60	.48	.60
V	.31	.07	1.37
W	3.73	1.42	1.19
X	2.17	2.03	1.02
Y	5.50	6.15	1.17
Z	1.87	1.63	.77
Average	2.91	1.56	2.28

One step toward reducing the energy

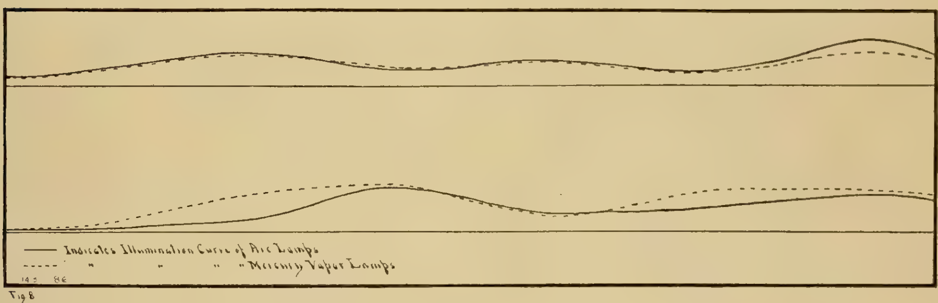


FIG. 7.

and still attempting to give sufficient general and detailed illumination was to install seventy 50-watt metalized filament lamps in two and four light clusters with 15-inch porcelain-lined reflectors. A still further reduction in power with greater intensity was effected by the installation of sixteen mercury vapor lamps with 21-inch tubes and regulation reflectors. In order to have every possible system represented a set of sixteen 3-ampere arc lamps was installed, each within a few feet of a vapor lamp as noted in Figure 4.

Each system was measured separately and readings taken at a distance of 3 feet 4 inches from the floor which corresponded with the height of most of the machines and benches. The test stations were located at the center of each of 26 bays, each bay containing approximately 250 square feet.

This test may be considered of value as it was made under actual working conditions.

TABLE 2.

	Mercury Vapor Lamps.	Metalized Filament Clusters.	New Arcs.	5 Old Arcs, 45 Incand.
Height of Ceiling	10′ 10″	10′ 10″	10′ 10″	
Height of Lamps	9′ 10″	7′ 10″	8′ 5″	
Height of Test Plane	3′ 4″	3′ 4″	3′ 4″	
Height of Lamps above Test Plane	6′ 6″	4′ 10″	5′ 1″	
Total Watts	3080	3500	5280	5558
Square Feet Illuminated	7044	7044	7044	7044
Number of Lamps	16	70*	16	
Average Watts per Lamp	192.5	50	330	
Average Watts per Outlet	192.5	125	330	
Average Sq. Ft. per Lamp	440	100	440	
Number of Test Stations	26	26	26	
Watts per Sq. Ft.	.431	.497	.749	.787
Sq. Feet per Watt	2.28	2.01	1.33	
Average Foot Candles	2.91	1.56	2.28	
Foot Candles per K. W.	.944	.446	.431	
K. W. per Foot Candle	1.059	2.243	2.316	
Foot Candles per Watt per Sq. Ft.	6.66	3.14	3.04	
Watts per Sq. Ft. per Foot Candle	.151	.318	.329	
Annual Cost as Installed	$220.48	$212.68	$278.34	
Annual Cost for 3 Foot Candles	226.96	409.06	366.24	

* Grouped into 21 two-light and 7 four-light clusters.

The foot candle readings of the three different systems are given in Table 1 and the results in Table 2, which latter includes some data on the original installation.

At the foot of Table 2 are the figures of the firm conducting the test on the maintenance of each system per year, based on their costs and experience and including interest on investment, cost of current and renewals for the number of lamp hours burned in this department.

The yearly cost as shown in the first row is for the illumination as tested and in the second row for an intensity of three foot candles which is deemed necessary for this class of work.

Figure 5 is a photograph of the Linotype Room of the Chicago *Tribune* when arcs were used; Figure 6 is the same room showing mercury vapor lamps.

An illumination test was made in this room under the arcs and another test a short time later under the vapor lamps which succeeded them, and which were hung in the same locations. Readings in both tests were taken at the same stations (Figure 6) and at a plane 4 feet from the floor, at which average height, it was observed, reading of copy was done as oper-

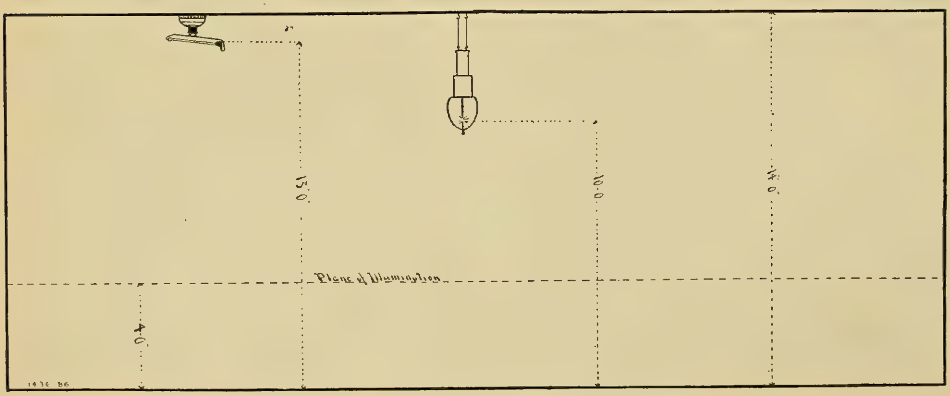


FIG. 8.

ators passed about the room. Each machine has of necessity its individual incandescent lamp. These were not considered in the test, which refers to general illumination only.

It is interesting to note that the readings of the two systems at each of the stations were very close together (Table 3) and the illumination curves in Figure 7 show the situation graphically.

The vapor lamps were of 21-inch tube length, provided with reflectors and hung 13 feet from the floor, and the arc lamps had dense opal outer globes, which accounts for the good diffusion. These lamps were hung so that the height of the arc averaged 10 feet from the floor. (Figure 8.)

The results of the test are given in Table 4.

The walls and ceiling were dark terra cotta and probably added nothing in reflection.

TABLE 3.

Station.	Arc Lamps.	Mercury Vapor Lamps.
A	2.95	2.06
B	.93	.85
C	1.62	1.50
D	1.00	1.74
E	2.12	2.00
F	.80	.78
G	.17	.33
H	.64	2.25
I	2.80	3.03
J	1.07	.95
K	1.42	2.57
L	2.3	2.69
Average	1.485	1.679

Figure 9 is a photograph of a machine shop illuminated by 6 twenty-one-inch mercury vapor lamps. Figure 10 is a photograph of a shop of nearly the same dimensions and area illuminated by 6 arc lamps. In both shops are a few scattered incandescent lamps used for special purposes, but are not taken into account in these tests.

The plans showing locations of lamps and test stations are given in Figures 11 and 12 respectively.

The character of work in the two shops is the same and the plane of illumination is taken at 35 inches from the floor at the average working level.

The average foot candle readings of the two rooms are given in the same Table (5), likewise the comparative results in Table 6.

TABLE 5.

Station.	Vapor Lamps, Figure 12.	Arc Lamps, Figure 13.
A	1.56	2.4
B	1.68	1.53
C	3.13	1.9
D	1.55	1.25
E	1.36	2.35
F	4.6	2.55
G	4.66	2.65
H	2.94	1.32
I	....	2.6
J	....	7.5
Average	2.68	2.00

Figure 13 is a photograph of the drawing room of the Illinois Steel Company of their North Works on Wabansia avenue, Chicago. This picture was taken late in the afternoon by daylight with mercury vapor lamps turned on to show their locations.

TABLE 4.

	Arc Lamps.	Vapor Lamps.
Height of Ceiling	14′ 10″	14′ 0″
Height of Lamps	10′ 0″	13′ 0″
Height of Test Plane	4′ 0″	4′ 0″
Height of Lamps above Test Plane	6′ 0″	9′ 0″
Total Watts	2310	1155
Square Feet Illuminated	4095	4095
Number of Test Stations	12	12
Number of Lamps	6	6
Average Sq. Ft. per Lamp	682.5	682.5
Watts per Sq. Ft	.56	.28
Square Feet per Watt	1.77	3.54
Average Watts per Lamp	385	192.5
Average Foot Candles	1.485	1.679
Foot Candles per Watt per Sq. Ft	2.65	5.99
Watts per Sq. Ft. per Foot Candle	.377	.167

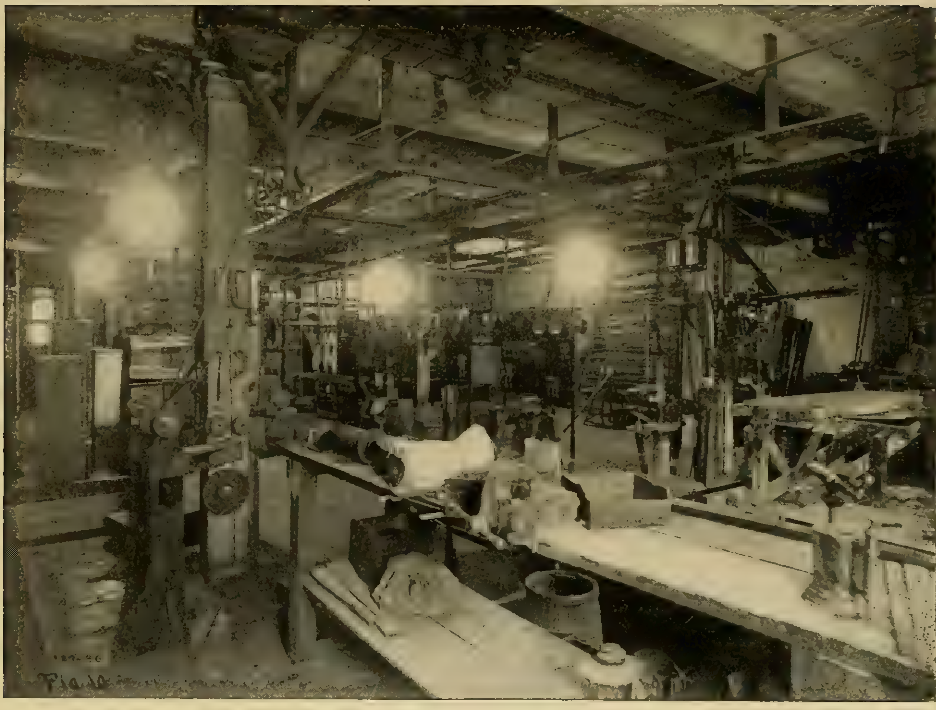


FIG. 9.

FIG. 10.

TABLE 6.

	Vapor Lamps, Figure 12.	Arc Lamps, Figure 13.
Height of Ceiling	11′ 6″	14′ 8″
Height of Lamps	8′ 8″	10′ 6″
Height of Test Plane	2′ 11″	2′ 11″
Height of Lamps above Test Plane	5′ 9″	7′ 7″
Total Watts	1155	3300
Total Square Feet Illuminated	2647	2744
Number of Lamps	6	6
Number of Test Stations	8	10
Average Watts per Lamp	192.5	550
Average Square Feet per Lamp	441	457
Watts per Square Foot	.436	1.2
Square Feet per Watt	2.29	.831
Average Foot Candles	2.66	2.00
Foot Candles per Watt per Sq. Ft.	6.12	1.66
Watts per Sq. Ft. per Foot Candle	.167	.6

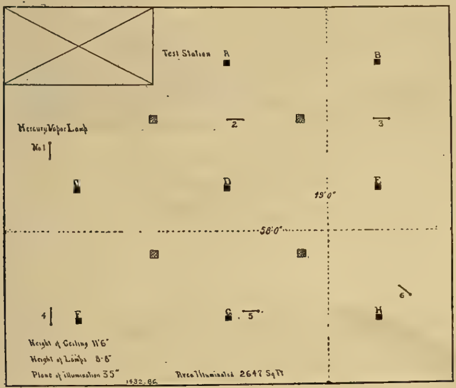


FIG. 11.

The lighting of this room was laid out by the writer in the spring of 1906, with the intention of giving an average intensity of 11 foot candles and as even a distribution as possible. Also to give the draughtsmen as nearly as possible the same direction of light as they would receive from the windows.

This was accomplished by hanging type K vapor lamps of 45-inch tube length in front of each window at a distance of one foot. The 4 lamps down the center finish the distribution.

The plan of the room with locations of lamps and test stations and the arrangement of drawing tables is shown in Figure 14.

The plane of illumination was taken at 42 inches from the floor which is the height of the table tops and the stations are located in each case directly upon a drawing.

It will be noted by referring to Table 7 that the foot candles average 9.7 or 13 per cent. less than proposed, which is easily accounted for in the accumulation of dust on the tubes and reflectors which were not cleaned for the occasion; in fact, they had not been touched since they were installed nine months before. The building is not far distant from the many smoking chimneys of the plant.

It may seem strange that this accumulation of dust would have such an effect on the illumination from the lamps, but a test made directly underneath lamp No. 3 in Figure 10 at a distance of 5 feet 9 inches showed 6 foot candles, and after the tube and reflector had been wiped off the reading was 6.7 foot candles or an increase of nearly 12 per cent.

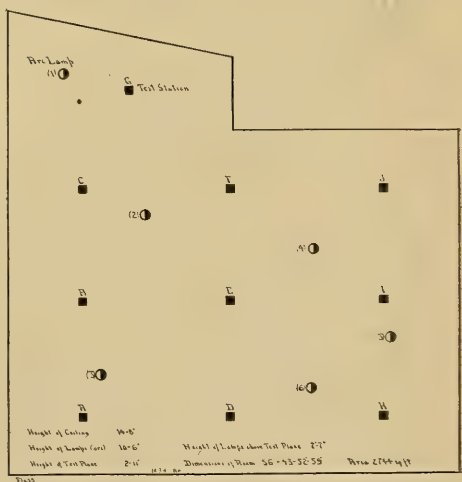


FIG. 12.

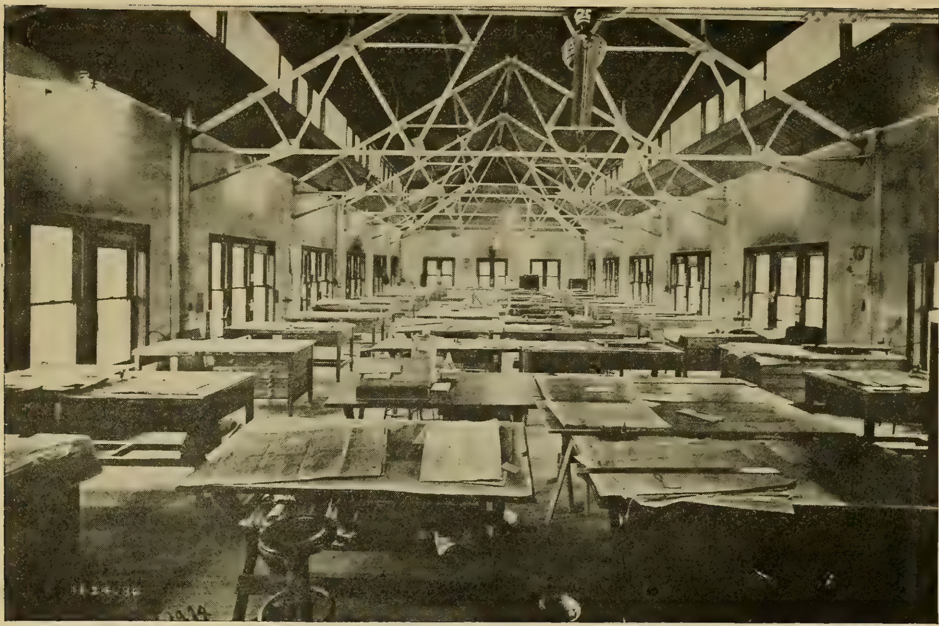


FIG. 13.

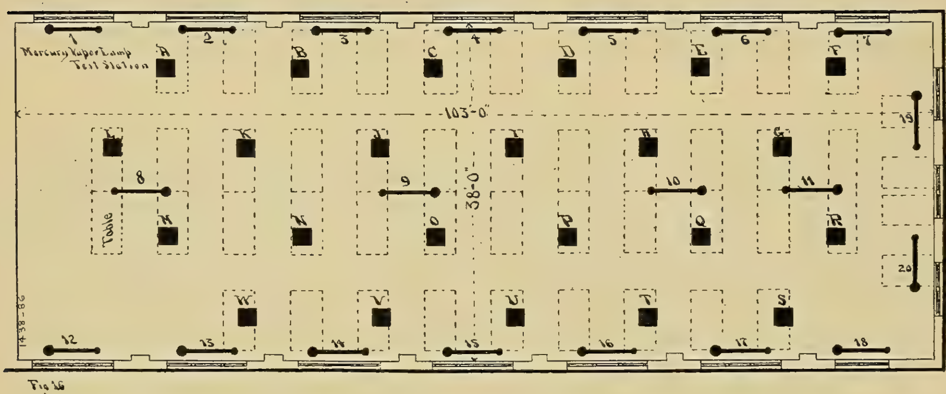


FIG. 14.

TABLE 7.

Illinois Steel Co.

Station.	Foot Candles	Station.	Foot Candles.
A	10.2	N	6.2
B	8.3	O	9.9
C	9.4	P	8.1
D	8.4	Q	11.2
E	9.5	R	11.7
F	13.3	S	11.3
G	10.9	T	10.2
H	11.5	U	9.1
I	7.2	V	9.8
J	9.1	W	8.8
K	8.7		
L	9.9		——
M	10.1	Average.	9.7

New York Edison Co.

Station.	Foot Candles.	Station.	Foot Candles.
1......	10.6	14......	14.0
2......	13	15......	13.8
3......	11.5	16......	16.2
4......	13.4	17......	16.2
5......	8.6	18......	15.2
6......	11.5	19......	15.7
7......	14.7	20......	12.2
8......	14.9		
9......	13.3		
10......	14.7		
11......	16.2		
12......	13.8		——
13......	10.6	Average.	13.5

As I could find no drawing room in the city of as high intensity with any other system of lighting I have compared it with the Duane Street Drawing Room of the New York Edison Company lighted by arc lamps with Concentric Diffusers, and referred to in Mr. Edward A. Norman's paper read at the March meetings of the New York and Chicago Sections of the Illuminating Engineering Society.

Table 7, second column, contains his readings taken at 20 stations, and I have added some data regarding distribution which is of interest.

In Table 8 the results of the two tests are compared.

TABLE 8.

	Illinois Steel.	N. Y. Edison.
Height of Ceiling to Girders	13′ 6″	13′ 6″
Height of Lamps	11′ 6″	11′ 0″
Height of Test Plane	3′ 6″	3′ 9½″
Height of Lamps above Test Plane	8′ 0″	7′ 3″
Total Watts	7700	12173
Total Square Feet Illuminated	3914	1519
Number of Lamps	20	17
Average Watts per Lamp	385	715
Average Sq. Ft. per Lamp	195.7	89.3
Number Test Stations	23	20
Watts per Square Foot	1.97	8.07
Square Feet per Watt	.508	.124
Average Foot Candles	9.7	13.5
Foot Candles per K. W.	1.27	1.11
K. W. per Foot Candle	.794	.901
Foot Candles per Watt per Sq. Ft.	4.92	1.68
Watts per Sq. Ft. per Foot Candle	.20	.600

	Illinois Steel.	N. Y. Edison.
Lowest Reading	6.2	8.6
Average Reading	9.7	13.5
Highest Reading	13.3	16.2
Maximum above mean.	3.6	2.7
Minimum below mean.	3	4.9
Variation	6.6	7.6

The above tests were made entirely on what may be termed low ceiling installation. It was impossible to include in this paper a very important class of lighting such as is used in large erecting shops and foundries equipped with 30 to 75 foot span cranes running the entire length.

Meeting of the Philadelphia Section, April 19

Definitions of Some Units Used in Illuminating Engineering

By W. A. Evans.

The ohm or International Ohm is the unit now universally used by which is here meant the International Ohm of the International Congress of 1893 in Chicago. It is the resistance of a column of mercury at 0° C. 106.3 centimeters long, weighing 14.4521 grammes and having a uniform cross section.

One ohm has such resistance that if one volt of electro-motive force were applied to it, one ampere of current would exist in it. Ohms = volts divided by amperes.

Volt or International Volt of the International Congress of 1893 in Chicago is that electro-motive force which will maintain one international ampere through one international ohm. The Clark standard cell at 15° C. gives 1.43 volts.

Volts equals amperes times ohms.

The ampere or International Ampere of the International Congress of 1893 in Chicago is 1.10 of the C. G. S. electro-magnetic unit of current. For practical purposes it is defined by that Congress as the current, which under special conditions deposits .001118 grammes of silver per second, but better defined as the amount of current which will exist in a resistance of one ohm when one volt of electro-motor force is applied to that resistance.

Amperes = volts divided by ohms.

The watt is the unit of power, defined by the International Congress of 1893 in Chicago as equal to 10^7 C. G. S. units of

power (erg per second). One watt = one volt × one ampere in direct current and non-inductive alternating current circuits. Watts = amperes × volts × power factor in inductive alternating current circuits.

One kilowatt = 1,000 watts.

One watt hour = one watt for one hour.

One kilowatt hour = 1,000 watts for one hour.

One horse-power = 33,000 foot pounds per minute.

One horse-power = 746 watts.

One hefner is the light produced from an amyl acetate lamp of fixed dimensions and height of flame. It is the accepted unit of intensity of light.

Candle-power is the intensity of light from one British standard candle, which is a candle of specified manufacture. One hefner = .88 English candle.

Mean spherical candle-power is the average intensity of illumination delivered from a source of light considering the total sphere of light.

Mean spherical candle-power is the average intensity of illumination delivered from one source of light considering either the upper or lower hemisphere.

Spherical candle-power is the total illumination delivered from a source throughout the total sphere of light.

Lumen is the unit of flux of light, and is the flux of light in a beam of one unit solid angle (one which subtends a square meter at a radius of one meter) in which the intensity is one hefner. One lumen = solid angle hefner.

Lux is the illumination produced on a surface by one hefner at a distance of one meter.

Lumen per watt express the efficiency of the light delivered to the energy consumed.

Lux per lumen is the ratio or efficiency of the illumination received to the illumination delivered, and obviously applies to placement of the source of light with respect to the surface to be illuminated.

Lux per watt is the ratio or efficiency of illumination received to the energy consumed.

Candle foot is the illumination on a surface, one foot from a one-candle source.

Candles per watt is the ratio or efficiency of illumination delivered to energy consumed.

Candle feet per candle is the ratio or efficiency of illumination received to the illumination delivered, and obviously applies to the placement of the source with respect to the surface to be illuminated.

Candle feet per watt is the ratio or efficiency of the illumination received to the consumption of energy.

Power depending upon coal is what is needed finally for illumination.

The horse-power, as I have stated here, equals 33,000 foot pounds per minute, *i. e.*, it is equivalent to the work done in raising one pound 33,000 feet in one minute, or 33,000 pounds one foot in one minute. Notice that it is the product of distance, force and time. The horse-power is the English unit of power. The "watt" is the C. G. S. unit, which means centimeter gramme, second unit, and one horse-power is equal to 746 watts.

Leaving now the fundamental electrical units and taking up the units used in illumination, we have the hefner. The "hefner" is the light produced from an amyl-acetate lamp of fixed dimensions and height of flame. It is the accepted unit of intensity of light in Europe. In America, on the other hand, the unit adopted is the candle-power, and one hefner is equal to .88 English candle. Now candle-power is a definite quantity of light. We have a sixteen candle-power light from which we get a certain amount of illumination. Does it mean that if sixteen candles were put in the place of that sixteen candle-power lamp we would have exactly the same illumination? Not at all. It means that if we were to hold that sixteen candle-power lamp at a certain place in a certain direction, and were to put sixteen standard candles a certain distance from it, if we were to go midway between them we would have exactly the same illumination from the two sources; but if we were to take that sixteen candle-power lamp and turn it in another direction, the illumination from it would not be equal to the illumination given by the sixteen candles.

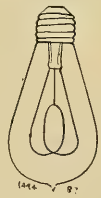


FIG. 1.

If we consider that the source of illumination is a bulk; that there is a certain

amount of light coming from that sixteen candle-power lamp, its brilliancy would be the same in every direction. Looking at the tip, it gives 7 c.p., and looking at it from the back it gives no candle-power; looking at all the filament (as in Fig. 1) it gives exactly sixteen candle-power. If we look at that lamp in all directions, it will vary throughout the whole sphere. Suppose we do that; say we look at it in one hundred directions, and all the readings, and divide by the total number of readings, we would have the average intensity given from that lamp; that is as though the candle-power could be all put together and then smeared out evenly.

We now have the "mean spherical candle-power," which is the average intensity of illumination delivered from a source of light considering the total sphere of light. That is, if we were to look at the light source in a number of directions and measure the candle-power, add them together and divide by the total number of readings, we would have the mean spherical candle-power.

The "mean spherical candle-power" is the average intensity of illumination delivered from one source of light considering either the upper or the lower hemispheres. Put a reflector above the light, and all the light will go down, and none of it going up. Therefore, the mean upper hemispherical candle-power is zero, whereas we have increased the lower mean hemispherical candle-power.

"Spherical candle-power" is the total illumination delivered from a source throughout the total sphere of light. Take any source of light, such as a sixteen candle-power lamp, and look at it from a number of different directions, the intensity of that light is different. Were it possible to divide it up into an infinite number of parts and then sum them all up, we would have the total spherical candle-power of that source.

The "lumen" is the unit of flux of light, and is the flux of light in a beam of one unit of solid angle (one which subtends a square meter at a radius of one meter) in which the intensity is one hefner. One lumen = one solid angle hefner.

I might state that the units of illumination as described by different men do not always agree, for this reason: Illumination is a new art, or science, and we have not definitely settled the units. Some substitute "candle-power" for "hefner" in the above definition. To my mind this is inconsistent, because the lumen is stated in the same paragraph, last sentence. One lumen = one solid hefner. If candle-power is placed in preference to hefner, the second definition is untrue.

I had better explain what is meant by a unit solid angle. I take a sphere one meter in radius, and on the surface of that sphere I describe a circle, that circle to include one square meter on the surface of the sphere. The cone formed by the elements connecting the circle and center of the sphere is a unit solid angle. If I place a unit of light at the apex of the cone, Fig. 2, the amount of light I have in that angle is a unit of flux of light which, to illuminate the surface on which it falls, is the total flux of light included in that space. Or, if I place one hefner at the apex I will have one lumen of light from the source.

It might be interesting to know that the angle between opposite elements of the cone is approximately 86 degrees.

"Lux" is the illumination produced on a surface by one hefner at a distance of one meter. That is, if I have a source of light of one hefner, I have a surface one meter distant, and the intensity of light on that surface is one lux, provided that the surface is the inside of a sphere. This limits us on flat surfaces to a point.

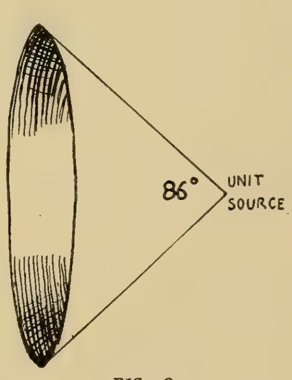


FIG. 2.

That is, if surface B C in Fig. 3 is one meter distant from the unit source at A, the point B alone will be receiving the intensity of one lux. At C, the distance is greater and the illumination is less on the surface at that point. "Lux" does not apply to the amount of surface covered by the light, but to the intensity of the light on

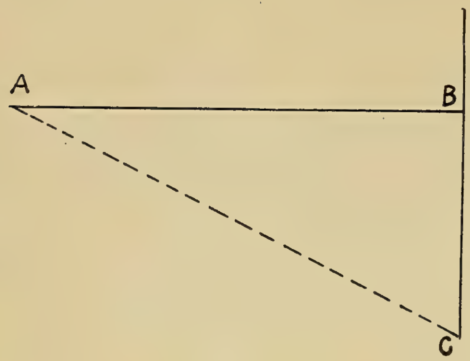


FIG. 3.

that surface. Everybody is familiar with the law that the intensity of light falls off inversely as the square of the distance from the source.

FIG. 4.

We have a source of light at A, Fig. 4, and a surface to be illuminated at B. The intensity of light on the surface at B we are absolutely certain is going to be greater than at C. Everybody has watched a light source coming toward them. For instance, you have watched the rapidly approaching headlight of an engine on the railroad, and have seen the intensity of the light increase as it comes toward you. Now suppose the distance from A to B is one foot, and that distance from A to C is two feet; by the law of intensity of illumination, the illumination on the surface at B should be four times as great as the illumination on the surface at C.

The little contrivance shown in Fig. 5 is the equivalent of a unit solid angle.

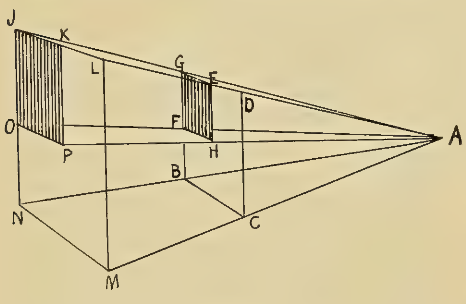


FIG. 5.

That is, the volume included within the wire edges is the equivalent of a unit solid angle, and if one hefner were placed at the apex at one meter distance, the illumination practically on that surface would be one lux. The distance from A to H is one foot, the distance from A to P is two feet, and the square A B G D is one square foot; and the square M N J L four square feet, or two feet square. If I place one candle-power at A, the card at H is cut that H F G E is one-fourth of the square C B G D. The illumination on P O J K is one-fourth as intense as on C B G D.

Now we come to some of the terms which express efficiency. "Lumen per watt" expresses the efficiency or ratio of the light delivered to the energy consumed. That is up to the manufacturer, whose duty it is to give us a light source or a piece of apparatus which will give us the greatest amount of light for the least consumption of energy. We have to deal then with the tools that are given us. We have to select the most efficient lamp or apparatus for giving us light, and then place that source in the proper place. We have seen that the "lumen" is the quantity of light. It measures light on the same principle that you would go out and get a quart of milk or anything of that character. It is the material idea of the fact that we are buying illumination. What is the quantity we are getting? We get illumination; we don't want to buy the energy, and therefore we must know the relation between the quantity we are getting and that which we are paying for.

"Lux per lumen." We have seen what a lumen per watt means; now what is lux per lumen? Lux per lumen is the ratio or efficiency of the illumination received to the illumination delivered; and obviously applies to placement of the source of light with respect to the surface to be illuminated.

If we have a source delivering a certain number of lumens through a unit solid angle; if I take that unit solid angle and place one hefner at the apex, I get a certain illumination on a surface. If I could place two hefners there, I would have two lumens. If I place sixteen hefners there, I have six lumens. Therefore we know that the lumen is the term which expresses intensity of the source. If we have a book in front of us with a certain intensity on the surface, if we measured it, we would say that we had a certain number of lux.

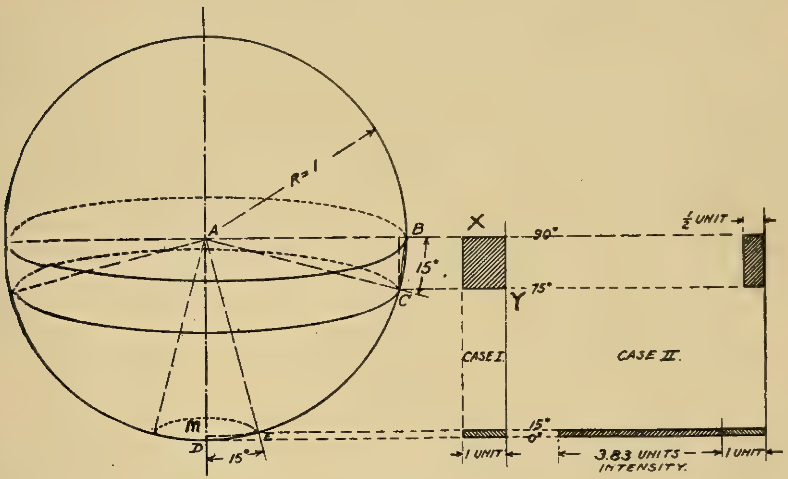


FIG. 6.—THE ROSSEAU DIAGRAM.

Lux per watt. We have seen what is meant by lux per lumen, and lumen per watt; now combine the two and we have "lux per watt," which is the ratio or efficiency of illumination received to the energy consumed.

Now I will leave the terms which are used in France, and come to the terms which we use in commercial practice.

Candle foot, more properly known as foot candle, or candle per foot squared, is the illumination on a surface, one foot from one candle source.

Candle per watt is the ratio or efficiency of illumination delivered to energy consumed.

Candle feet per candle is the ratio or efficiency of illumination received to the illumination delivered, and obviously applies to the placement of the source with respect to the surface to be illuminated.

Candle feet per watt is the ratio or efficiency of the illumination received to the consumption of energy.

It may be that some of the points brought out in Mr. Woodwell's paper were not quite clear to all of us, and it might be well to run over some of these fundamental points. There is a proposition in geometry which proves that the area of a square equals the height of the zone X circumference of a great circle. Unless some one wishes it, I will not take the time to demonstrate this, although I will be pleased to do so after the talk is over, if we have time.

Suppose there is a source of light at A, Fig. 6, this is a sphere of unit radius—we will consider this to be a full source; that the source in every direction is delivering one unit of light, and then over the whole body of the sphere we will have the same intensity. If we take the point at C, which is 15 degrees below the horizontal, this area of the zone generated by D C is approximately 7⅔ as great as the zone generated A B, although the angle is 15 degrees. Now, then, the illumination in the zone generated by B C will be represented by X Y. This is one unit intensity, and if we take a certain portion of the surface, the intensity is exactly the same in one zone as in the other, but the amount of light around the first zone is greater than the second. If there is one unit intensity on B C and D E, suppose we borrow from the upper zone an intensity of one-half unit; then as we put a reflector on our lamp, or source, throw the light downwards; suppose we only take a little bit of that light and throw it down; Mr. Woodwell considered that if we took half a unit away from the upper zone and redirected it, throwing it right down to the lower zone, then the amount of intensity in the lower zone is increased and will be 3.83 units, or the total intensity in this zone will be 4.83 units in 15 degrees; or, the amount would be 1½ the area of the zone generated by B C.

area of zone generated by D E.

We have taken a small intensity from the upper zone. Notice how very much it is increased, and yet out through the upper zone we do not need it. We do not care about illuminating the walls; we want the light down below. Therefore place a shade on your lamp; borrow a small

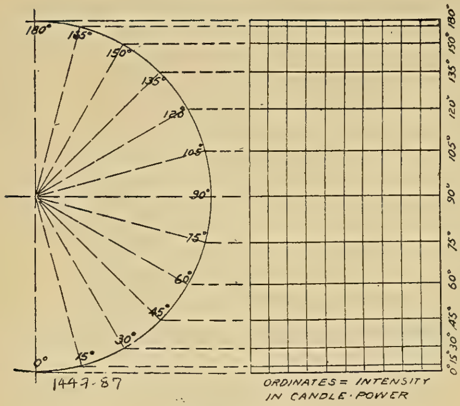


FIG. 7.

amount of light from the sides and notice how much you increase the intensity of the lamp where you want it, if that is the particular problem you have in mind.

The Rosseau Diagram is a diagram for getting down to work quickly, and to determine the mean spherical candle-power, or first the total S. C. P. We know that the height of the zone × the circumference of a great circle gives us the area of the zone, and we know that the area of the zone represents the amount of light when multiplied by the candle-power in that direction. Now, then, we will take the zone between 0 and 15 degrees. The height of that zone is D M. The length of circumference of a great circle is constant. Then the height of the zone will represent in every case the amount of light in that zone, and since the area of the zone represents the amount of light, if we take a candle-power curve—which everybody is familiar with.

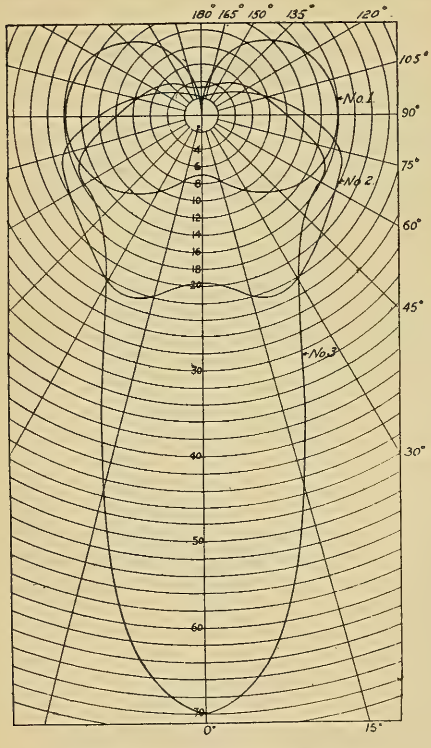


FIG. 8.—CANDLE-POWER CURVE.

In Fig. 8, No. 1 is a curve without the reflector. If we take a photometer and measure the candle-power of that lamp in the direction indicated by the lines, and mark these various points, the point represents the candle-power in that particular direction. Running, then, a line from these points, we have the candle-power in different directions, or can interpolate the candle-power in that direction which we have not taken.

The other curves indicate the candle-power from that same lamp by introducing a reflector. You will notice there seems to be a great deal more light coming from the source with the reflector on the lamp than when it is off, but it must be remembered that reflection is what we want. If we want light out on the sides, this reflector is of no value. There is no more light coming from the source in one case than in the other. If we were to multiply these distances by the candle-power at these various angles, we would then have the intensity of light throughout the total sphere, and if we take the area of such a plot, between the curve and the base, we will have the total candle-power coming from that lamp. If we divide by the length of the base, it will give us the mean spherical candle-power.

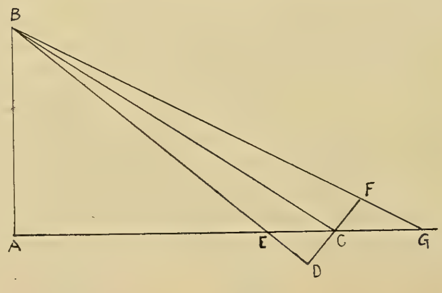


FIG. 9.

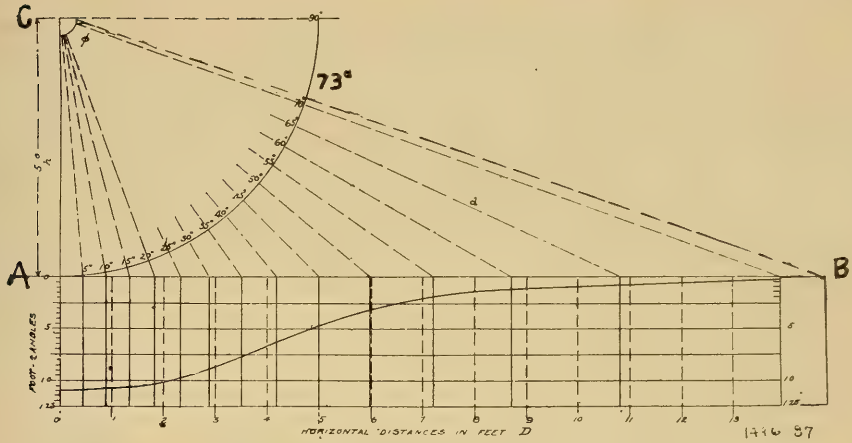


FIG. 10.

The last point that I wanted to take up was how to arrive at the illumination on a surface.

If we have a source of light at B, Fig. 9, and the light were to fall on the surface D F, which were exactly perpendicular, that is, to the line of light, the illumination on the surface at C, which, from a knowledge of our units, would be the candle-power of our lamp in that direction divided by the square of the distance. But suppose for the instant that we consider this: That it were to fall on the particular surface; now the surface to be illuminated is not D F but E G, and we have a greater surface between E G than we have between D F. Therefore the intensity on the plane E G cannot be so great as it is on D F. We know this from trigonometry, that B C = A B ÷ the consine of the angle A B C. If that is the case, the intensity on D F would be equal to the C. P. of the course C ÷ A B^2 ÷ cos 2 A B C.

That is, if we square the quantity A B cos A B C. But by similar triangles the angle F C G = the angle A B C, and its surface, since we have equal angles, would be increased to the extent of dividing by the cosine of the angle A B C. That is, we will further divide by the cosine of A B C, which gives us the (candle-power of the lamp C divided by A B^2) × by the cosine cube of the angle A B C, which you will notice in Mr. Woodwell's paper is the method of determining the illumination on that surface when we know the angle A B C.

There have been tables set down giving the various cosines of angles; therefore we do not have to work them out.

Now, if we have a source of light falling on plane, Fig. 10, through the various angles; if we make A B 10 units, and 3 units from A to C, we can apply this diagram by adjusting the distance to any installation, and knowing that this ratio gives us approximately 73 degrees, it brings us ten times the distance from directly under our source to a point included within 73 degrees where the perpendicular distance is 3 units. Now, then, if we take a point 60 degrees, we know that the candle-power of the lamp, if the lamp were placed at C; if it were placed in the photometer and measured at 60 degrees from the vertical, and know it to be a certain amount, we multiply that candle-power by the cosine cube of 60 degrees and divide by the square of the perpendicular distance, and we have the intensity on the surface in foot candles. This curve here has been worked out at the intensity in foot candles. Fig. 10 is the illumination curve of a Tantalum lamp with a reflector.

Interior Illumination, with Special Reference to Public Halls

By T. J. Litle, Jr.

I have taken up the question of lighting a public hall from probably a novel standpoint. It is comparatively easy to calculate the number of foot candles required in a certain space for certain purposes, but it is sometimes a little more difficult to design the particular reflector for particular lighting.

In the case of a public hall of any kind, I think it desirable to keep the light source from the eyes of the audience, and while

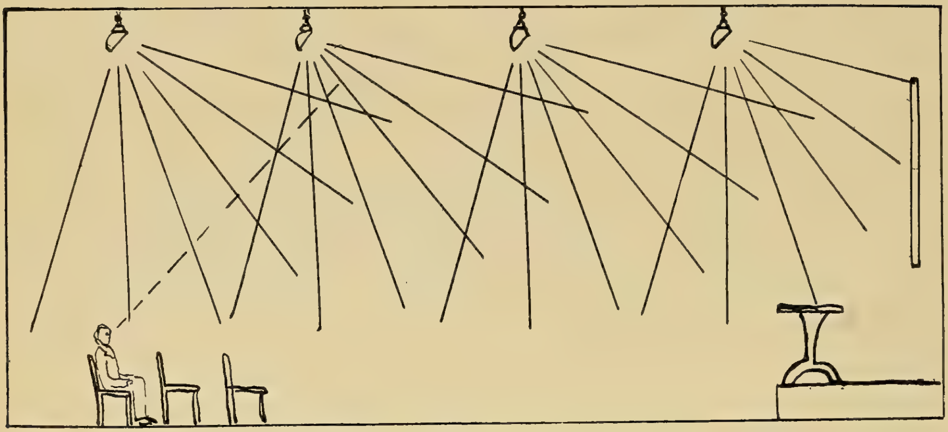


FIG. 1.

the light is directly in the speaker's eyes as he stands here on the platform and looks down the room, he is only one of a large number, I think it is best that the audience should be considered, and practically considered wholly, and for that reason we have adopted a scheme for lighting the room with lamps throwing the light directly away from the eyes of the audience.

Fig. 1 is a diagram showing a section through the room, and a rough lay-out of the room.

The reflectors here shown throw most of the light forward and below, and throw but very little backward. If the audience looks up it sees nothing but the green bowl, and the effect on the eye is not displeasing.

I might say that most of our theaters are poorly lighted, if the lamps were on during the performance, but instead of that we turn them down, and bring out the lamps on the stage; otherwise it would be annoying to watch the play. Most lecture rooms and draughting rooms are poorly lighted. In most draughting rooms I know it is objectionable to look up from the board to the lamp. In most college drawing rooms the students face in one direction; that is, toward the instructor at the end of the room, and as it is often necessary to look up, it is annoying to have to look directly into the lamp.

The general design of the lamp should be one which would obscure it by a reflector. In any event, we should never use a bare lamp.

The form of lamp shown in Fig. 2 gives a fairly good illumination.

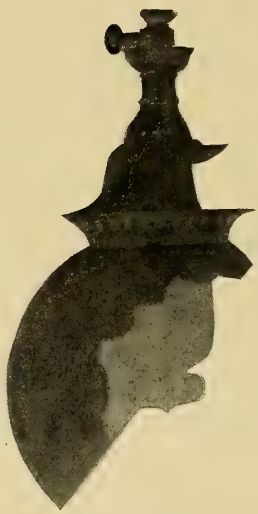


FIG. 2.

The reflector is made of a double blown glass, a green plated glass, lined with white on the inside, made by dipping the blowpipe first into a batch of opal glass, and then into a green glass, having a composite mass on the pipe and blowing it into the mold which will form the spherical globe; green on the outside and white on the inside. This is then cut off at the angle shown in the picture.

The inner cylinder is frosted around the front half, the back of the cylinder being clear. That is the cylinder which we recommend for this kind of lighting. In this case we have the mantles obstructed and throwing the full light on to the reflector. As I stand here on the platform I see these

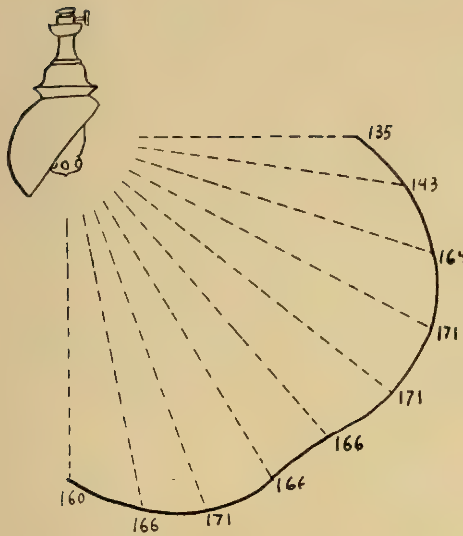


FIG. 3.

frosted cylinders and the inside of the reflector, which combination is not so objectionable as it would be if the cylinder were clear.

The distribution curve shown in Fig. 3 is irregular, and may appear surprising to some of you. The shade was designed to give a uniform curve, but you see a little lump in the curve that was caused in rather a peculiar way, viz.—by the several thicknesses of the glassware below the mantle. The light at this point passes through three thicknesses of glass.

These lamps are lighted electrically from a central point, the jump-spark ignition system being used, which gives the convenience of electric lighting.

Discussion of Mr. Evans' Paper

Mr. W. H. Gartley.—This seems to me to be a most important paper, because in starting with any subject, it is always best to thoroughly understand our definitions, particularly the definitions of our units. If this paper, which is headed "Definitions of Some Units Used in Electrical Illuminating Engineering" is intended to be definitions that will apply to all branches of illuminating engineering; that is, gas as well as electricity, I, as the self-appointed and very temporary representative of the gas interests, want to say that I have to demur to some extent on some of the definitions. Probably the one that appeals to me strongest is the statement that "one hefner is the light produced from any amyl-acetate lamp of fixed dimensions and height of flame, and that is the accepted unit of intensity of light."

When electricity was a puling infant—before it had developed its fangs—the gas interests had a unit of light known as the English candle, and I believe the English candle is yet their unit of light. As everyone knows, other countries have their units of light . Various committees have been appointed by several societies in the last few years to look into this question of a standard unit of light, and it is hoped by some that they will agree, but up to the present time they are far from agreeing.

Perhaps the clearest statement that can be made of the standing of the Hefner lamp is, that instead of it being the unit of light, it has been called the "custodian of the unit"; that is, when we say that the Hefner lamp is 88/100 of the value of the standard English candle, we have a means of determining what the intensity of the standard English candle is, because, by reason of the large amount of work that has been done by the German experts on proportioning the various parts of the Hefner lamp, we are told that the individual Hefner lamp varies less than the individual English candle.

If you want to find out what is the intensity of one English candle, instead of preparing and lighting a candle, you are advised to burn a Hefner lamp and multiply its intensity, as shown on the bar photometer, by 1.14.

The value of the English candle, as defined by the London gas referees, does not recognize this definition as being 100/88 of the hefner. These gas referees define the intensity of light from one English standard candle as being 1/10 of the value of the pentane lamp, burned under normal atmospheric conditions.

This latter definition of the value of the English standard candle has been accepted for years by certain of the gas companies in this country and abroad; consequently I want to demur to the statement that the hefner is the accepted unit of light.

There are some other matters which I will not take up now, but I would suggest that since the speaker has kindly prepared this paper, we take it home and discuss it at some other time. For instance, "candle foot is the illumination on a surface one foot from one candle source." That would require some discussion on the part of the gas people, because we have another definition.

Mr. Evans.—I might say this: That the object of the paper was to give in as concise a manner as possible, for our present use, the definition of such units, as we use every day, and I have not gone into a technical discussion of, for instance, the hefner, or the English candle, as I believe Mr. Bond did that in a previous lecture, in discussing the manufacture of the English candle, or the absolute dimensions of the pentane lamp.

Mr. Gartley's remarks are very apropos, in this way, that I am purely electrical, not gas, and know nothing about it, and therefore have only gone into such units as I am familiar with, but I think Mr. Bond went into these units that Mr. Gartley speaks of, in his previous lecture, and therefore I am not going into that subject at this time. The hefner I spoke of as being the accepted unit, for this reason: As I understand it, it is the unit used by the National Bureau of Standards, and that they check the unit of candle-power with it. But I certainly appreciate your remarks as adding to what I have said.

Mr. W. H. Gartley.—The Bureau of Standards in Washington did not accept or state that the unit of light is the hefner. They are waiting at the present time to see if the committees of the American Institute and the American Institute of Electrical Engineers will adopt the candle-power unit, defining it as 100/80 times the hefner unit.

Discussion of Mr. Litle's Paper

A Member.—Have estimates been made of the candle foot illumination on a plane, say two feet six inches or three feet above the floor?

Mr. Litle.—I have not figured it out for this room; we would get in similar installations perhaps twelve or thirteen candle feet, but that is a mere guess—probably a high one. The consumption of these lamps is three feet per hour: sixteen lamps take 48 cubic feet per hour, lighting about 800 square feet of floor surface.

A Member.—I think the lay-out in this room is a very desirable one, for the type of unit used, but I also think that the high intrinsic brilliancy displayed is not so desirable, inasmuch as too much illumination is as bad as too little. If the lamp were lower in intensity, it would present a more pleasing appearance. However, as the lecturer remarked, halls are sometimes furnished with dark coloring on the walls, which absorbs a certain amount of light, and in that case tne glare might be softened.

Mr. Litle.—Of course all of us have different ideas as to the proper kind of light for a given purpose, just as physicians have different ideas on the proper kind of milk to give a baby, and it is hard to lay down a law which would suit us all. I myself like a large volume of light, so long as the source is not visible. I get very sleepy in a light of low intensity, and do not concentrate my gaze properly on the speaker.

C. R. Green.—Is it possible to turn the lamps down?

Mr. Litle.—Yes; the lamps can be turned down by simply turning the checks on the burners. There is a thumb-piece on the side of the burner by which you can get any candle-power you like.

C. W. Pike.—However much we might argue with the speaker as to the proper intensity of illuminants—and I would agree that the intensity is higher than needed—at the same time, I think this particular illumination is useful in allowing us to contrast it with the very low degree of illumination that we have with the electric light, as even with this very great illumination, I think you will agree that the ease on the eye is very much greater—that there is a marked rest—as compared with the electric illumination.

The method of illumination shown here is illustrated in actual practice in one of the rooms of the Engineering Department at the University of Pennsylvania, in the lecture room of the Architectural Department, but they have one modification, which is that the fixtures are placed back a little, and are so designed that none of the direct rays of light come directly upon the screen, so that it is not necessary to change the illumination of the room at all when the lantern is in use.

Papers Read Before Technical Societies

Light from Gaseous Conductors within Glass Tubes—The Moore Light

By D. McFarlan Moore.

Read before the American Institute of Electrical Engineers. (Abstract.)

Some years have passed since I first realized that there then existed no form of artificial light that could truthfully be said to imitate daylight. Believing unalterably that such a light was to be the next logical step of great importance in artificial illumination, I commenced an investigation that still continues.

To duplicate daylight closely, three premises were soon determined upon which have never been abandoned:

1. Large light source, the practical solution being a long glass tube emitting light.
2. Use electricity flowing through a gaseous-conductor, not a solid conductor.
3. Perfect imitation of color values.

Immediately on beginning investigation on these premises, the gaseous-conductor became the factor of greatest importance. The life of the first lamps or tubes constructed was extremely short, since, as then expressed, "the vacuum deteriorated." Up to date, four methods made have been developed and used and thousands of experiments have been made concerning the replenishing of the gas and thereby overcoming this vital difficulty of the gaseous-conductor becoming non-conducting, due to the peculiar chemical reaction that must occur when electricity passes from a solid conductor to a gaseous-conductor. These methods are as follows:

1. By obtaining a cycle of events through catalytic action. The intensity of light possible was found to be very low.
2. Obtaining a cycle by evaporation and condensation. Probably mercury is the only element that can ever be used in this way in glass tubes.
3. By re-supplying the necessary gases automatically by the action of heat on suitable substances.
4. By automatically feeding gas to the tube when needed, which is the method used at the present time.

The general law of all light sources applies also to the vacuum-tube light; namely, the higher the temperature the greater the efficiency. The absolute temperature of the individual particles of matter within the tube after collision is greater than that of any other temperature on earth. But the quantity of heat of each of these ultra incandescent, though infinitesimal, bodies, is so small that there results that which at first would seem paradoxical: namely, the "coldest" source of light. In this expression we crudely refer to the external temperature of the entire tube. Some gases are easily ionized and conduct well, yet give practically no light, which may indicate that their chemical constituency and therefore their emissivity is not suitable for light production.

The illumination of this assembly room, Fig. 1, at the present moment by a so-called Moore vacuum tube, greatly facilitates making clear not only its mechanical construction, but also its many other salient advantages and characteristics. The electrical energy is obtained from the alternating-current street mains.

It will be noted that the light emanates with absolute uniformity from the entire area of a single, continuous glass tube 1.75 in. in diameter in the form of a large rectangle 62 ft. by 25 ft. which is supported on the cove designed to conceal the incandescent lamps. The glass tube is 13 in. from the ceiling and 16 ft. from the floor.

It is supported by plain brass rings 1⅞ in. in diameter attached to small porcelain insulators inserted in the ends of brass fix-

FIG. I.—ASSEMBLY ROOM OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

ture tubing which of course contains no wires.

The two ends of this continuous tube at the center of the rear side of the rectangle approach within such a short distance of each other that the gap is scarcely discernible from the floor. They then extend horizontally through the wall and into a rigid steel terminal-box located on the wall of the closet at the rear of the hall. This terminal-box contains all the necessary electrical apparatus and corresponds in form and size with that shown in Fig. 2. It is fed by 60-cycle alternating current at 220 volts. Besides the two carbon electrodes of the tube, the terminal-box contains a step-up transformer and a small specially designed valve with its solenoid, which represents an entirely new departure in vacuum tube lighting and also one that is vital to its success. The electrical circuits from this apparatus are extremely simple and are shown in Fig. 3. There is no distributed or high-potential wiring. The high-potential terminals of the transformer within the terminal-box are only two or three inches in length and are attached directly to the electrodes within the box. All the high-potential wires, therefore, always remain within the box which has a wire seal placed upon it. A hand can be placed on each of the glass tubes where they emerge from the two holes in the side of the box, but the glass tubes insulate the gaseous-conductor within them so well that no shock can be felt.

Since the feeder-valve operated by the solenoid just mentioned is an essential feature of this system, a description of its operation will be interesting. Any vacuum tube when commercially luminous will, in a few minutes, seriously alter the degree of its vacuum unless special provision be made to replenish its gaseous-conductor. Due to flow of current, a portion of the residual gas within the tube is absorbed; that is, changed to a solid form, and thereby the degree of vacuum in the tube becomes higher.

This higher degree of vacuum so increases the resistance of the tube that at first the light simply becomes unsteady, but rapidly changes to a condition of violent spasmodic flickering, which soon entirely ceases and the tube gives no light whatever. The light has actually died for want of air. This simple fact was not recognized for many years by prominent inves-

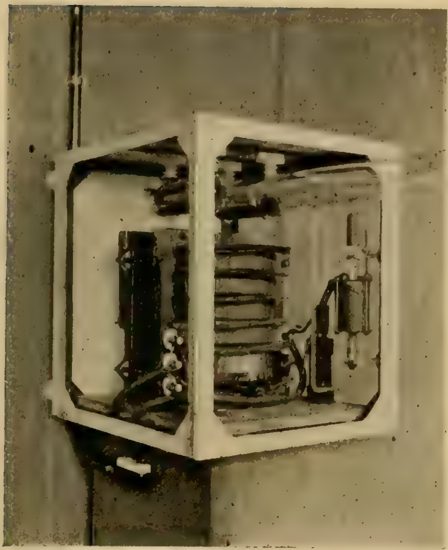


FIG. 2.—INTERIOR OF TERMINAL BOX.

tigators in this line of phenomena. The problem, therefore, was to devise thoroughly practical means for replenishing the gaseous-conductor of a vacuum tube. This is the function of the feeder-valve which permits air or other gas to enter the tube only when it is needed and in such a manner that it is entirely automatic. A piece of ⅞-in. glass tubing is supported vertically, see Fig. 5, its bottom end is contracted into a ⅜-in. glass tube which extends to the main lighting tube. At the point of contraction at the bottom of the ⅞-in. tube there is sealed by means of cement a ¼-in. carbon plug, the porosity of which is not great enough to allow mercury to percolate through it, but which will permit gases easily to pass, due to the high vacuum of the lighting tube connected to the lower end of the plug, and approximately atmospheric pressure above it. This carbon plug is normally completely covered with what would correspond to about a thimbleful of mercury, which simply seals the pores of the carbon plug, and therefore has nothing whatever to do with the conducting properties of the gas in the main tube which produces the light. Partly immersed in the mercury and concentric with the carbon plug, is another smaller and movable glass tube, the upper end of which is filled with soft iron wire, which acts as the core of a small solenoid connected in series with the transformer. The action of the solenoid is to lift the concentric glass tube partly out of the mercury, the surface of which falls and thereby causes the minute tip of the conical-shaped carbon plug to be slightly exposed for a second or two, and an extremely small quantity of air or other gas filters through it and then finds its way into the vacuum tube proper. In normal operation, most of the tubes expose this carbon tip for about one second every minute. Therefore, this system, broadly speaking, consists in continuously burning air electrically.

Fig. 4 will explain the theory of this action still more clearly. This curve shows the relation between conductivity and degree of vacuum. Of course there must be a critical degree of vacuum at which the conductivity is a maximum; this point corresponds to *X*. By means of the adjusting screw at the top of the solenoid the degree of vacuum is kept normally at a lower vacuum corresponding with *Y*, therefore as the electricity uses up the gaseous-conductor, the

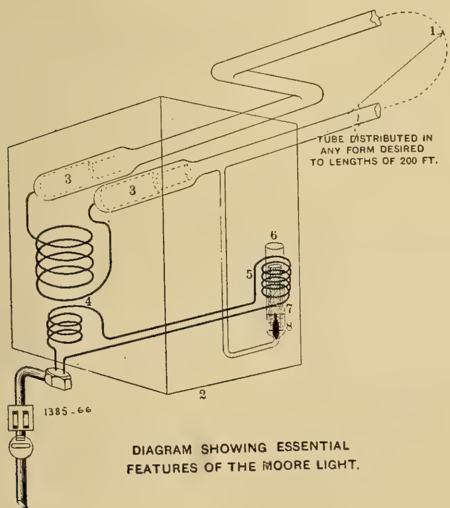


FIG. 3.

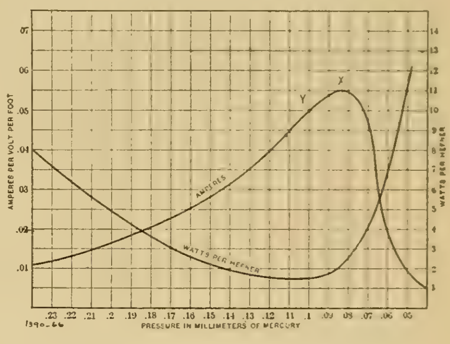


FIG. 4.

vacuum of course becomes higher, the conductivity better, and a greater current flows through the solenoid, causing it to lift the displacer and expose the carbon tip above the surface of the mercury. In viewing its action, one is vividly reminded of a mud-turtle taking a breath of air on a mill-pond. As others have expressed it, this apparatus actually breathes. Immediately upon the air being admitted the vacuum falls, its resistance increases, and the current through it decreases as does also the current from the mains; therefore, the feeder magnet weakens and the displacer falls, thereby shutting off the air or gas inlet. This cycle is repeated about once a minute throughout the life of the tube, which is indefinitely long. Of course when the tube is not in service there is no leakage of air or other gas through the mercury covering the plug.

In table I the comparative illumination tests were made between the Moore tube located in the lobby of a large theater and the incandescent lamps formerly used to light the same area.

TABLE I.

ILLUMINATION MEASUREMENTS IN HEFNER-FEET IN THE LOBBY OF A THEATER.

	Moore Tube.	Incandescent System.
Mean illumination (average hefner-feet of 16 stations)	3.12	1.09
Average variation from mean	27%	16%
Average volts	222 a.c.	115 d.c.
Amperes	21	51.75
Watts total	3075	5470
Power-factor	66	——
Area square feet	2110	2110
Watts per square feet	1.46	2.82
Illuminating efficiency: Mean hefner-foot / watts	2.15	0.39

Therefore the tube system has 5.1 times the illuminating efficiency of the incandescent lamp system under the same local conditions. The useful illumination has been increased 450 per cent., yet the current consumption is reduced 45 per cent.

The tube is not provided with a reflector of any kind and therefore the ceiling was much brighter than when the incandescent lamps were used, most of which were located directly on the ceiling. The walls and ceiling are covered with a buff-colored paint. The tube operated directly from the street mains, 220 volts, 60 cycles, single phase.

If this tube had been longer its efficiency would have been still better, and by equipping it with a simple white reflecting enamel on the exterior of its upper half it would have had the benefit of a reflecting surface like most other forms of light in normal operation. Measurements of tubes so equipped show an efficiency corresponding to less than one watt per hefner and therefore approaching the theoretical limit for a light of such a commercially good spectrum.

The entire basement floor of a department store, which is solely lighted by four tubes each about 200 feet in length, is shown in Fig. 5. This basement was formerly lighted with enclosed alternating-current, 6-ampere, 60-cycle, arc lamps. The goods are generally displayed on tables and shelves on the side walls, and the plane of measurement was chosen at the average height of the tables; that is, 36 in. from the floor.

The ceiling is 10 ft. 3 in. high and coated with gray paint. The tube is 199 ft. long, operating directly from the 60-cycle street mains; that is, there are no auxiliary devices to be taken into account as with some other forms of light. The center of the tube is 8 ft. 9 in. above the floor and the center of the arc lamp 8 ft. 6 in. above the floor. It was noted that various articles are suspended from the ceiling in this department, and that with the tube light the ceilings and walls were well illuminated, while with the arc lamps, due to

TABLE II.

ILLUMINATION MEASUREMENTS UNDER TUBE "B," DEPARTMENT STORE.

	Moore Tube.	Arc Lamp System.
Mean illumination (average hefner-feet of 22 stations)	2.6	1.6
Average variations from mean	31.8%	40.4%
Average volts	230	122
Amperes	24	53.1
Watts total	3500	4500
Power-factor	62.5%	70
Area square feet	3753	3753
Watts per square feet	0.93	1.2
Illuminating efficiency: Mean hefner-foot x area / watts	2.79	0.967

FIG. 5.—BASEMENT OF DEPARTMENT STORE.

their reflecting shades, the ceilings and walls very dark.

In table II the comparative illumination tests were made between tube "B" when fed with pure nitrogen and therefore giving a yellow light, and the nine arc lamps provided with 15-in. white opalescent reflector shades formerly used to illuminate the same area.

Therefore the tube system with yellow light has 2.9 times the illuminating efficiency of the enclosed arc-lamp system under the same local conditions.

The efficiency of this tube in terms of watts per hefner instead of watts per hefner-foot was determined by direct photometric measurement instead of by illuminometer measurements. An accurately constructed photometer placed upon this tube showed it to be operating at 12 hefners per foot, which is equivalent to 2,388 total hefners and an efficiency of 14 watts per hefner power from the street mains. This figure is obtained by simply dividing the total watts delivered to the tube from the city service mains by the total number of hefners. If the losses of the terminal-box are deducted, the actual efficiency of this tube, simply as a light source—which is the manner in which practically all other light sources are usually rated—reaches the remarkably high figure of 1.3 watts per hefner. When a Moore tube is diffusing its yellow light, one seems at least to be able to see far better than when it is producing the same hefner power of white light.

TABLE III.

ILLUMINATION MEASUREMENTS UNDER "C" TUBE, BAMBERGER BASEMENT.

	Moore Tube.	Arc Lamp System.
Mean illumination (average hefner-feet of 16 stations)	1.12	0.65
Average variation from mean	37.5%	51.7%
Average volts	227	122
Amperes	42	59
Watts total	5750	5000
Power-factor	61%	70%
Area square feet	4275	4275
Watts per square feet	1.34	1.17
Illuminating efficiency: $\frac{\text{Mean hefner-foot x area}}{\text{watts}}$	0.83	0.55

The useful illumination has been increased 220 per cent., yet the current consumption reduced 22 per cent.; this amounts to a saving of 10 cents per kilowatt-hour.

On account of the remarkable color qualities of the white Moore light, a request was made to change two of these yellow tubes over the china department to a white color. In table III the comparative illumination tests were made between tube "C," 211 ft. long, when fed with pure carbon dioxide gas, and therefore giving a white light, and the ten 6-ampere, 60-cycle arc lamps provided with 12-in. spherical opalescent globes.

Fig. 5 is a photograph of this department taken solely by the light of the tube.

Therefore the white tube is 1.5 times more efficient than the enclosed arcs.

Although the above tests indicate that this system is now the most efficient light source known, nevertheless not only theory but experiments already made show that greater advances in efficiency are yet to be made. The best gaseous conductors particularly adapted for selective radiation must be determined upon. For example, nitrogen has about twenty times the efficiency of hydrogen. A gaseous-conductor must also be selected that not only has proper color values, but must maintain high efficiency over wide ranges of intensity; for example, mercury vapor (to say nothing of its color) is very inefficient in the long-tube system. It is only efficient at intensities which should be considered too high and which is also the reason why the mercury tube is so sensitive to temperature changes.

Moore tubes are now used in lengths varying from 40 to 220 feet. The following curves show the watts per hefner for 40 feet to be 2.5, and for 220 feet to be 1.4, on the basis of a yellow light. Therefore when tubes are operating at 12 hefners per foot, which is the average intensity now used, tubes from:

40	to	70	feet	use	a 2-kw.	transformer.
80	"	125	"	"	a 2.75-kw.	"
130	"	180	"	"	a 3.5 "	"
190	"	220	"	"	a 4.5 "	"

In order to insure steady light, the power-factors of the circuits supplying these transformers average at present 65 per cent. This is obtained either by using a shell-type transformer of special design with a leakage reactance of about 65 per cent., depending on the size of the transformer required, or there can be used a standard type of core transformer, operated in series with a special type of adjustable inductance consisting of two composing coils on the center leg of an iron core of the shell-type formation.

Feeder-valve solenoids of four sizes have been found sufficient, and are usually connected in series with the low-tension circuit of the transformer and inductance, although they are sometimes operated by the high-tension circuit.

Although the average power-factor is now about 65 per cent., there is no theoretical reason why all these tubes should not operate at a considerably higher power-factor. In fact a very recent improvement in the valve which has entirely eliminated capillary attraction, has made it practical to adjust tubes to a power-factor as high as 84 per cent.—which is a decided improvement over some of the first tests published, and makes the tube far better than either the alternating-current motor or the arc lamp in these respects. Since all of the electrical factors of the entire system are based on the conductivity of the gas column, it is possible to vary the power-factor over a wide range simply by changing the degree of vacuum by regulating the amount of gas fed to the tube.

The following curves show the relations existing between the salient factors that have to do with the tube performances.

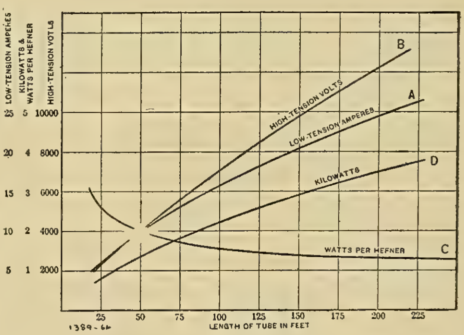


FIG. 6.

Curve *A* shows how the amperes of a low-tension side of the transformer at 220 volts vary with the length of the tube.

Curve *B* indicates that the actual voltage on the tube terminals for 40 feet is 3,146, and for 220 feet 12,441 at 12 hefners per foot.

Curve *C*. Since the no-load transformer losses and also electrode losses become a larger percentage of the total watts as the tubes are shorter, therefore the watts per hefner grow less: that is, the longer the tube the better the efficiency.

Curve *D*. Doubling the length of a tube does not double the kilowatts required.

Curve *E*. These tubes soon become seasoned; that is, use up all foreign gases, and then their intensity remains perfectly constant for an indefinitely long period of time.

Curve *F*. The efficiency also remains constant.

Curve *G*. The efficiency does not vary over a wide range of supply voltage.

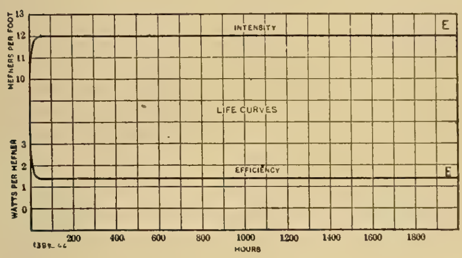


FIG. 7.

Curve *H*. The light intensity is directly proportional to the voltage, not as the square or the cube of the voltage as is the case with incandescent lamps. This is an advantage of great practical importance.

Curve *I*. The light intensity is nearly proportional to the watts.

Curve *J*. The light intensity is proportional to the tube amperes, and that a tube radiating 13 hefners per foot of yellow light requires three-tenths of one ampere.

The degree of vacuum required in these tubes is about 0.10 of a millimeter which, comparatively speaking, can be called a high vacuum. This vacuum is maintained within 0.01 of a millimeter of 0.00001 per cent. of an atmosphere either above or below the normal degree of vacuum. The solution of this very difficult problem of maintaining a degree of vacuum so nearly constant, was found by taking advantage of the fact that but slight changes in the vacuum cause

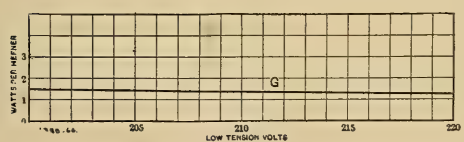


FIG. 8.

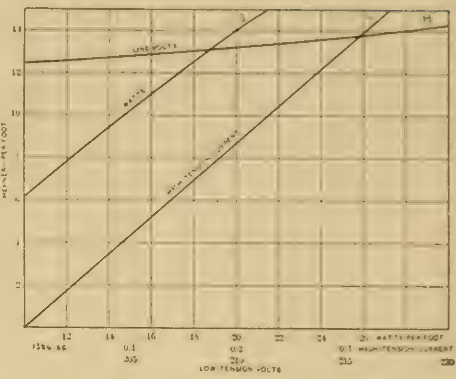


FIG. 9.

enormous changes in the electrical resistance of a gaseous-conductor. For example, a tube 220 feet long at its lowest vacuum (0.11 mm.), takes 24 amperes, but at the end of every minute this has crept up to 25 amperes, when a new supply of gas causes the amperes slowly to drop again to 24. Of course it is impossible to detect this slight oscillation either in the steadiness or intensity of the light in the tube. Making use of electricity to govern the vacuum is equivalent to using a multiplier of about 400,000.

These long tubes are built in place by hermetically sealing together 8 ft. 6 in. lengths of 1.75 in. glass tubing, with walls 1/16 in. thick, by means of a new blast illuminating gas—fire or double-flamed torch. This work can be done rapidly and cheaply since in a 100-ft. tube about a dozen joints are needed and only about about two minutes are required for each one. This has necessitated the development of a new trade: namely, "glass plumbing."

The two ends of the tube within the terminal-box each contain a graphite cup electrode 8 in. long. Immediately in front of one of these electrodes a branched small-bore tube extends to the bottom of the feed valve, see Fig. 3, and the other branch is available to be connected temporarily by a rubber hose to a new small portable oil vacuum-pump. The electricity is turned into the tube shortly after the pump is started and the amount of light resulting indicates in a measure the degree of vacuum in the tube. But in investigating a field of this nature a simple, rapid, and accurate vacuum-gauge was found to be very necessary, and it has proved to be as valuable an instrument as a compass is to a mariner. It can be calibrated to measure to one ten-millionth of an atmosphere.

As soon as the vacuum of the tube is sufficiently high, the feed-coil is adjusted to feed at proper intervals the right quantity of air or other gas. When the light automatically and continuously feeds itself from the atmosphere, the supply of which is of course inexhaustible, its life can be said to be indefinitely long. When it is desired to feed the tube on nitrogen only, the air is simply made first to pass through a small iron cylinder containing enough phosphorus to last several years. Should a longer life than this without any attention be desired, several cylinders can be used in series and these can be renewed an indefinite number of times at a negligible cost. Effectually to prevent more than is necessary of the atmosphere from coming into contact with the phosphorus, or being continuously in contact with it when the tube is not in use, it has first to pass through a small mercury trap.

To feed the tube CO_2, a bottle containing a piece of marble and a little hydrochloric acid automatically generates this gas only when the tube requires feeding. Therefore this small gas generator needs only a new piece of marble at the end of several years.

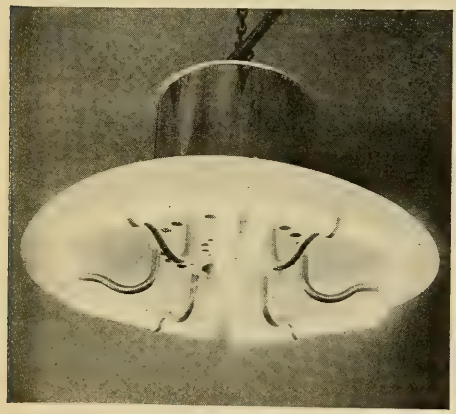


FIG. 10.—A SMALL MOORE LIGHT UNIT.

Various portable or unit forms of this light have been designed. For example, the one shown in Fig. 10 resembles somewhat of an arc lamp. It operates at 220 volts and requires 25 per cent. less watts yet gives 25 per cent. more useful illumination than an enclosed arc.

The automatic feeding-valve is of course applicable not only to alternating-current vacuum-tubes, but also to direct-current vacuum-tubes. It can be made invaluable for all kinds of vacuum-tube apparatus, such as X-ray tubes, vacuum oscillographs, wireless telegraphy or telephony, transmitters and receivers, vacuum or vapor rectifiers, or lamps.

A careful analysis of this system of illumination in general, discloses the large number of advantageous features it possesses. It is the first artificial light that can rightly be called imitation daylight. Natural daylight is the only ideal light that can ever exist and the eye accords with it, therefore the nearer any light source approaches it the better, and vice versa. The absence of the red rays in daylight, for example, would far from improve it. This system is so much nearer natural light imitation that it is in a class by itself. But these tubes furnish a perfect diffusion of light because the light radiates from such extremely large areas as compared with all the old-style spots of light, and therefore if desired a more nearly shadowless light can be produced than by any other known means.

It is simply claimed that this new system of electric lighting gives the up-to-date illuminating engineer one more available method for solving some of his problems and that some of its fields, as is the case with all other lights, are exclusively its own.

The term spherical candle-power manifestly cannot apply any more logically to a long tube than can the law of inverse squares be properly applied to its light emanation.

Since it is possible and practicable to use these tubes graduated from an intensity of light per foot that is almost negligible up to 30 or more hefners per foot, it is impossible to state arbitrarily just what is the intrinsic brilliancy of a Moore tube. The average long tube now in use operates at 12 hefners per foot. The following table compares the tube with some other illuminants on the basis of hefners per square inch:

Moore light	at 6 hefners per foot	0.33
	at 12 hefners per foot	0.66
	at 36 hefners per foot	2.
Cooper Hewitt mercury tube		19.
Incandescent filaments		250.
Nernst glower		600.
Arc crater		10,000.

Some authorities have stated that an intensity greater than about 5 hefners per square inch is beyond the theoretically cor-

rect limits, therefore this light is the only one that has a low enough brilliancy not to fatigue the eye. This has also been demonstrated by practice. It is remarkable that an intrinsic brilliancy as low as 0.33 per square inch is commercially thoroughly practical.

That great progress has been made in tube lighting is clearly proved by calling attention to the fact that the tubes in the "Moore Chapel" at the Madison Square Garden Electrical Show of 1898 operated at only ¼ of a hefner per foot while now a hundred times this intensity is easily reached.

Stroboscopic tests of the light of the tube reveal an image better than that obtained from enclosed arc lamps, notwithstanding the fact that the heat-constant of the tube as the current wave passes through zero is less than that of any other form of light. Therefore when the supply switch is opened the tube light "goes out" quicker than all other lights, a fact which should be valuable for signaling, but which also in a measure explains the high efficiency of the tube. Tubes of this nature will operate successfully on all frequencies, but at frequencies as low as 25 cycles the images will probably become too pronounced unless two- or three-phase currents are available, in which case by the use of multiple tubes the images of moving objects are entirely removed. The highest frequency in use at present for operating these tubes is 480 cycles, and is furnished by a motor-generator on 220 volts direct current. Careful tests on various frequencies up to about 10,000 cycles have shown that the number of alternations of the current used to excite these long tubes has nothing to do with their efficiency.

During the first year of its use—1903—the gaseous-conductor of the Moore tube was produced by chemical means, which has been comparatively recently superseded by the automagnetic valve. Therefore the lapse of time since the first automatically fed tubes were installed being so short, it is not now possible to state definitely what their final life will be, beyond the general statement that some of these tubes have already been in operation over 4,000 hours without change, and that there are good reasons for believing that they should continue to run at least again as long, which is a much longer life than any other form of illuminant yet invented. This whole system is one with an exceptionally large number of variables, and this also applies to its life, because it depends partly on the intensity at which the tube is operated and the particular gas used. Since air or other gas is regularly admitted to the tube and changed to some solid form, due to certain electrochemical reactions, it is certain that the time of operation without any attention whatever cannot be prolonged indefinitely. Before adopting the chemical method of obtaining a nitrogen supply for the long tubes, it was stored under about three pounds pressure in a small tin cylinder placed in the terminal-box, which supplied an average tube before needing to be recharged for considerably over a year. Therefore the quantity of gas (nitrogen for example) necessary to support a light of 12 hefners per foot is so small that a tube of average length should remain in perfect condition for a number of years before it would be expedient to remove the small quantity of dark-colored powder which may have accumulated only within or near the graphite electrodes.

When a tube has been properly exhausted, the discoloration in front of the electrodes should not at any time extend more than two or three inches. When a tube is striated, it indicates that other gases are present that are foreign to the one decided upon to be used.

The light source of all other lights needs to be renewed, but in this case the light-giving tube itself will last an indefinitely long time, since it it neither consumed nor becomes blackened in the least. Should any renewal be required it is at the electrode which can be replaced comparatively cheaply.

The cost of a long-tube installation, due to its being construction work, varies with its location, its length, its shape, the intensity of the light required, the kind and number of fixtures desired, and other local conditions; but is already less than the cost of a first-class incandescent lighting system with its necessary wiring, fixtures and shades. Eventually it will be far cheaper. It should be borne in mind that the first cost of this tube corresponds with the entire cost of an incandescent lighting system—its iron piping, wires, cut-outs, fixtures, shades and lamps—and also that the first cost should be considered only in connection with the fact that in many instances this tube will pay for itself several times over during its first year of use from the amount saved on what the current bills would have been if incandescent

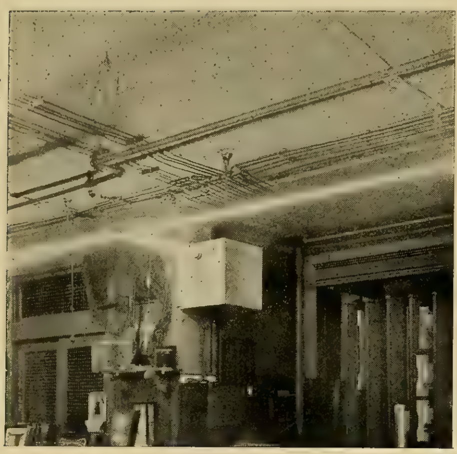


FIG. II.—EXTERIOR OF TERMINAL BOX.

lamps had been used to produce the same amount of useful light.

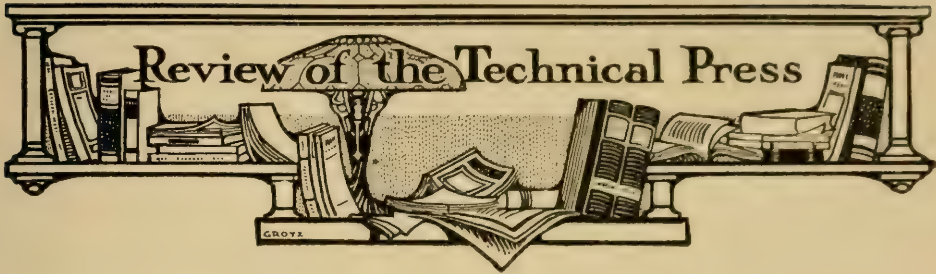
The light-giving tube itself is harmless either to life or property. The terminal-box is made of steel with a slate bottom so that even though the small transformer within it should completely break down, smoke only would result. It is impossible for the exterior of the terminal-box to get hot enough to set fire to anything. It is carefully designed so far as ventilation is concerned, and is always mounted so that there is an air-space all around it. With this loop tube system, aside from the ordinary short fed circuit, there is no part of it to be classified as a "risk" since all of the purely electrical apparatus is securely contained in a fireproof terminal-box.

Owing to the high efficiency of the tube and the large area from which any heat accompanying the light can radiate, the temperature of the tube is remarkably low, being in the neighborhood of 100° Fahr., therefore it cannot injure either perishable goods or the health of those working under it.

When these tubes are supplied with CO_2, they appear pure white. Most inexperienced persons, especially when contrasting the tube light with reddish lights, criticise the color as being too blue without realizing that daylight is a decidedly bluish-white. The laws of nature make the operating expenses of the pure white light tube almost double that of the yellow-light tubes, because the eye is affected to a maximum degree by yellow rays. But the white tubes which simply contain CO_2 have been used for over a year by stores in their ribbon departments for matching colors, day and night, because its spectrum remains absolutely constant. There are many other industries where color values are of vital importance. Also, since the color factor is now under perfect control, those light rays can be scientifically selected which are essential for the forcing of all kinds of plant life, flowers, fruits and vegetables. The color of the light can be varied by feeding the tube any gas as each has its own spectrum, or by using multiple valves, etc., mix various gases within the lighting tube itself. White tubes are daily being put to most vigorous tests at the works of one of the largest silk dyeing establishments in this country, but no difference can be detected in the most delicate shades when matched either under the tube or in average natural daylight. For some time past artists have been mixing their colors at night under the white tubes. Portrait photographs are also being made under it that equal those of natural light. Since the yellow tube light is about the same as that of the incandescent lamp it is being used successfully by clothing merchants and florists. Also on account of its uniformity of intensity it has proved its superiority for photographic printing.

It is interesting to note how different the same tubes lighting an ordinary store window appear in the afternoon when the sun is shining and after seven o'clock at night. The tubes that are yellowish white at night time appear orange colored during the day, and the tubes that are a pure and dense white at night appear a pale blue during the day—in fact, if exposed to brilliant daylight no light can be seen in them at all.

It is believed and hoped that the ideas advanced in this paper are simply in the direction of progress; that, aside from all theory, the facts show that electric illumination resulting from incandescent gases or vapors has vastly less limitations because their molecules or atoms are free to vibrate while those of solids are not, and therefore at the high temperatures necessary are subject to rupture; that "the signs of the times" clearly indicate that we have reached the beginning of the end of lighting by solid conductors and the end of the beginning of lighting by gaseous-conductors.



American Items

PRACTICAL ILLUMINATION, by James Raley Cravath and Van Rensselaer Lansingh; McGraw Publishing Co., New York. Price, $3 net.

The book is largely a reprint of articles that have appeared serially in the *Electrical World* for several years past. To the readers who have followed these articles little more need be said in commendation of the work. In addition to the reprinted articles there are two chapters dealing with "The Laws and Measurement of Light" and "Light and the Eye."

The title of the book is particularly well chosen, as the treatment of the subject is above all things practical. Great additional value is given tc the treatment of the various methods and types of lighting by the liberal use of cuts made from photographs of actual installations. Probably the most valuable single feature of the work is the large number of distribution curves given, which cover practically all present forms of commercial light sources, globes, shades, and reflectors. In addition to the curve, an illustration reproduced from a photograph of the article tested, is shown, enabling the reader to tell at a glance exactly what article the curve refers to. The data for the different curves shown was all obtained from tests made at the Electrical Testing Laboratory, New York, which not only ensures freedom from any possible commercial bias, but also uniformity in the methods and apparatus used in making the tests, which render results in every way comparable. In treating of the various phases of interior illumination—and it may be mentioned here that exterior illumination is not touched upon—the general method pursued is to elucidate the principles involved by a discussion of actual examples, pointing out what is considered good practice, criticizing fauty methods and giving suggestions for improvements. The whole treatment of the subject is free from abstruse terms, and mathematical formulæ, and is thus rendered particularly valuable to the busy practitioner or consumer, as well as to those who find themselves face to face with illuminating engineering problems, but who have not had the advantage of extensive technical training.

On the whole, this work is a valuable contribution to the literature of illuminating engineering. Besides its special value to the individual engineer and user of light, it cannot fail to have a large influence in establishing the claims of illuminating engineering as a distinct branch of science and art.

EFFECT OF FROSTING UPON THE LIFE OF INCANDESCENT LAMPS: Preston S. Millar, *Electrical World*, April 20th.

This article gives the results of a

series of experiments conducted at the Electrical Testing Laboratories for the purpose of determining the cause of the remarkable shortening in the useful life of a lamp by frosting. Mr. Millar comes to the same general conclusion as that reached by Dr. Hyde of the Bureau of Standards; namely, that the frosting does not have any appreciable effect upon the disintegration of the filament, but that the comparatively rapid decrease in candle-power of a frosted lamp is due simply to the absorption at the inner surface of the bulb due to the multiple reflection from the outer frosted surface. In a frosted lamp that has fallen to 80% of its initial candle-power, Mr. Millar ascribes 2.9% to change in the filament, 5.1% to blackening of the interior of the bulb, 5.1% to absorption from the multiple reflections, and 6.8% to the accumulation of dust on the outer surface.

A Brief Theory of the Reduction in the Service Life of Frosted Incandescent Lamps: Dr. A. E. Kennelly, *Electrical World,* May 18th.

Taking the explanation for the shortening of the useful life of frosted lamps as given by Dr. Hyde and Mr. Millar, Dr. Kennelly attacks the problem from a mathematical standpoint. The results obtained from this mathematical discussion of the problem seem to substantiate the explanation given.

Hotel Fairmont: *Journal of Electricity, Power and Gas,* May 11th.

An illustrated article describing the fixture installation and illumination of this magnificent new San Francisco hotel.

Bulletin of the Bureau of Standards: S. W. Stratton, Director, Washington, D. C., Vol. 3, No. 1 The work accomplished by the Bureau of Standards, as set forth in the Bulletins which are issued from time to time, amply justifies the confidence of the legislators who brought it into existence, and stamps it as an institution of which every citizen may feel proud. An inspection of the table of contents of any one of the numbers is a revelation to those unfamiliar with the extremely theoretical and scientific basis upon which the various measurements governing every branch of commerce are founded. For example: "The influence of basic lead acetate on the optical rotation of sucrose in water solution" would appear to the average layman to have no more practical bearing upon the affairs of ordinary life than "the forms of clouds at midnight a year ago." And yet every pound of sugar brought into this country, which is by far the larger part used, pays a duty based upon the peculiar action which sweetened water has upon a beam of light that has been treated in a certain way. As abstrusely scientific as the title appears, it treats upon a subject bearing directly upon the payment of millions of dollars annually.

Of particular interest to illuminating engineers is the fact that a due proportion of time and attention of the Bureau has been taken for investigations bearing upon the subject of photometry. In the number referred to there are papers on the following:

Complete Form of Fechner's Law. This is probably an unfamiliar subject to most illuminating engineers, and yet it deals with a law which governs the sensation of vision, and its scientific importance may be judged from the fact that all measurements of light are made by judgments based upon the visual sense.

A Comparison of the Unit of Luminous Intensity of the United States with those of Germany, England and France. The importance of this investigation is self-evident, and the

paper will be found reprinted in full in another section of this issue.

Geometrical Theory of Radiating Surfaces with Discussion of Light Tubes. In this paper the variations from the ordinary law of inverse squares, of light given out by tubes, such as the Moore tube, is mathematically developed. Since tube lighting bids fair to become an important element in illuminating engineering, this article is of particular value.

The Bulletin may be had on application to the Director of the Bureau.

A Comparison of the Unit of Luminous Intensity of the United States with those of Germany, England, and France.

By Edward P. Hyde.

From the Bulletin of the Bureau of Standards.

In inaugurating the work in photometry at the Bureau of Standards several years ago it was decided to adopt at once a working standard which could be maintained uniform, and in terms of which lamps submitted for verification could be standardized, and to defer the adoption of a primary standard until a thorough investigation of various primary photometric standards could be made. A comparison of the standards used by a large number of incandescent lamp manufacturers in the United States showed differences of 10 per cent. or more and emphasized the need of authoritative photometric standards, copies of which could be supplied to lamp manufacturers and others making photometric measurements.

Obviously it was desirable to have the secondary standard which was to be maintained at the Bureau in as close agreement as possible with the standards employed in industrial practice in the United States. In the gas industry the British parliamentary candle is the recognized primary standard and has been used quite generally as the working standard, although in recent years it has been supplanted to some extent by the Harcourt (10 c.p.) pentane lamp. In the photometry of electric lamps, following the recommendation of the American Institute of Electrical Engineers, the Hefner lamp has been recognized as the primary standard, but the luminous intensity of a source has been expressed in British parliamentary candles, using the ratio 1 Hefner = 0.88 British candle.

The British candle is thus universally the unit of luminous intensity in the United States, and it was therefore adopted as the unit in terms of which the standard of the Bureau should be expressed. But the British candle as a standard is unreliable and may have values differing by 5 per cent. or more, so that the value of a candle unit obtained from a standard sperm candle would not be satisfactory. It was therefore decided to obtain the candle unit in the way recommended by the American Institute of Electrical Engineers, with one essential difference. Since Hefner lamps which do not differ in intensity from the standards of the Reichsanstalt by more than 2 per cent., are certified by that institution as correct, and since, owing to the difference in color between the Hefner lamp and ordinary illuminants, comparisons between the Hefner and other sources depend somewhat on the observer, two observers using different certified Hefner lamps may obtain results differing by several per cent. Therefore, instead of measuring at the Bureau a number of incandescent lamps in terms of several Hefner lamps in our possession, the Hefner unit was obtained directly from the Reichsanstalt by means of incandescent lamps verified at that laboratory in terms of their Hefner lamps. In this way it was hoped to obtain a standard expressed in terms of the Hefner unit of the Reichsanstalt.

The unit of the Bureau was obtained from these lamps by the use of the ratio, 1 Hefner = 0.88 candle. This unit was found to be in approximate agreement with the mean value of the candle in use by many lamp factories and testing laboratories, and was therefore in no sense an innovation. Since the establishment of the unit, all the principal lamp factories and testing laboratories have obtained copies of it directly or indirectly, so that this unit has now become in practice as well as in theory the standard of the United States in the photometry of electric lamps.

Since obtaining the original lamps, several comparisons of the standard of the Bureau with that of the Reichsanstalt have been made by means of seasoned incandescent lamps sent to Germany, each comparison indicating that the ratio of our unit to that of the Reichsanstalt had remained unchanged to within the errors of observation. Moreover, measurements made

both at the Reichsanstalt and at the Bureau of Standards on incandescent lamps belonging to the Electrical Testing Laboratories of New York,[1] showed the Bureau unit equal very closely $\frac{100}{88}$ of the Reichsanstalt unit.

In order to obtain an accurate comparison of the unit of the United States with those of England and France, and to obtain a further comparison with the unit of Germany, the writer carried a number of seasoned lamps abroad in the spring of 1906, and had them compared with the recognized standards of these countries. eighteen lamps were taken, nine of which were 50-volt, 64-watt, horseshoe filament lamps which had been standardized for intensity in a specific direction defined by lines etched on the bulb. The other nine lamps were 110-volt, 64-watt, oval anchored filament lamps which had been standardized for mean horizontal intensity (the mean intensity perpendicular to the axis of the lamp) by the method of rotating the lamps at 180 revolutions per minute. Three lamps of each type were left at the National Physical Laboratory at London as a check on the others which were taken to Paris and Berlin.

The lamps were hermetically sealed in copper boxes and were carried entirely by hand in order to avoid excessive jarring. They were taken in the order named to the National Physical Laboratory, the Laboratoire Central d'Electricité at Paris, the Physikalisch-Technische Reichsanstalt at Berlin, and then again to the National Physical Laboratory. They were intercompared and measured in terms of the standards of the Bureau immediately before leaving and as soon after returning as practicable.

At each laboratory, except the Reichsanstalt, the method employed for determining the mean horizontal intensity of the six 110-volt lamps was the same as that used at the Bureau. At the Reichsanstalt the method of rotating a pair of mirrors about the lamp was employed. Moreover, the distance at which both the stationary and rotating lamps were measured was approximately 125 c.m. at each laboratory except the Reichsanstalt, where the 50-volt stationary lamps were compared at a distance of 300 c.m., and the other six lamps at a distance of 450 c.m. The difference in distance was occasioned by the use of the *two* mirrors in measuring the mean horizontal intensity of the 110-volt lamps.

An investigation was subsequently undertaken at the Bureau to determine what differences in the values of mean horizontal intensity might result from the two different methods of making the measurements. The results of this investigation, which was extended to a study of all the possible errors incident to the determination of mean horizontal intensity by the rotating-lamp method, are given in a separate paper in the last volume[2] of this Bulletin. For oval anchored filament lamps the values of mean horizontal intensity determined in the two ways would probably not differ appreciably, although it is impossible to conclude definitely from the results obtained by one observer what the results would be for a second observer. The flicker, which is plainly perceptible even with lamps of the oval anchored filament type rotating at 180 revolutions per minute, is more annoying and more productive of error with some observers than with others. Two observers at the Bureau, however, obtained correct values of mean horizontal intensity for these lamps to within negligible differences.

The possible errors due to the difference in distance at which the measurements were made were also investigated, by comparing the intensities of the lamps at a long distance with their intensities at a much shorter distance, using the rotating sectored disk. In the case of the stationary lamps a bad centering of the filament produces different apparent intensities at different distances. With the rotating lamps images are cast by the bulb in different directions and at various distances from the lamp, and the light radiating from these images has of course a different effective center from that radiating directly from the filament. In the orientation of stationary lamps care is always exercised to avoid a direction in which an image is thrown, but in rotating a lamp the light in every direction in the horizontal plane falls on the screen so that it must be shown by experiment what differences in the apparent intensities obtained at different distances may result from these images. Although the error due to such an effect would no doubt be quite appreciable if measurements were made with the lamp in such a stationary position that an image would fall directly on the screen, in rotating the lamp

[1] Sharp: Trans. International Electrical Congress, St. Louis, I, p. 492; 1904.

[2] Vol. 2, p. 415.

TABLE I.

Values of Candlepower and Current Obtained at the Different Laboratories.

Lamps	Voltage	Bureau of Standards		National Physical Laboratory		Laboratoire Central		Reichsanstalt		National Physical Laboratory		Bureau of Standards	
		Candle-power	Current	Candle-power	Current	Candle-power in bougies décimales	Current	Candle-power in Hefner's	Current	Candle-power	Current	Candle-power	Current
B. S. No. 44....	49.0	17.4_1	1.3326	17.6_8	1.3330	17.7_0	1.3325	19.9	1.333	17.7_2	1.3330	17.3_8	1.3325
B. S. No. 45....	49.0	17.3_1	1.3304	17.6_3	1.3306	17.5_5	1.330	19.6	1.331	17.4_2	1.3306	17.2_4	1.3302
B. S. No. 46....	49.5	17.3_1	1.3225	17.6_3	1.3229	17.5_7	1.323	19.5	1.323	17.6_0	1.3230	17.2_8	1.3225
B. S. No. 49...	49.5	17.5_9	1.3301	17.7_0	1.3302	17.7_5	1.3295	19.9	1.330	17.7_4	1.3305	17.5_2	1.3301
B. S. No. 50....	49.5	17.3_8	1.3283	17.5_8	1.3284	17.5_0	1.328	19.6	1.328	17.5_0	1.3288	17.3_0	1.3282
B. S. No. 64....	50.5	17.7_0	1.3328	17.9_5	1.3325	18.0_0	1.333	20.1	1.333	18.0_0	1.3331	17.6_3	1.3328
Means	....	17.4_5	1.3294	17.7_1	1.3296	17.6_8	1.3293	19.7_7	1.3297	17.6_6	1.3298	17.4_0	1.3294
B. S. No. 4....	109.0	16.2_6	0.5973	16.5_0	0.5975	16.5_5	0.5965	18.5	0.597	16.5_7	0.5975	16.1_5	0.5974
B. S. No. 7....	108.0	15.9_0	0.5947	16.1_1	0.5944	16.0_5	0.5937	18.0	0.594	16.2_5	0.5946	15.8_8	0.5944
B. S. No. 8....	109.0	16.0_2	0.5851	16.3_0	0.5852	16.4_0	0.5850	18.3	0.584	16.3_0	0.5852	16.0_5	0.5850
B. S. No. 13....	109.0	15.7_8	0.5936	16.0_7	0.5938	16.4_0	0.5932	18.1	0.593	16.0_8	0.5939	15.8_1	0.5937
B. S. No. 30....	109.0	15.7_8	0.5852	16.0_4	0.5855	16.0_5	0.5848	18.0	0.585	16.0_8	0.5855	15.7_3	0.5854
B. S. No. 40....	109.0	16.2_5	0.5984	16.7_3	0.5986	16.7_0	0.5970	18.6	0.598	16.6_4	0.5986	16.3_1	0.5984
Means	....	16.0_0	0.5924	16.2_9	0.5925	16.3_6	0.5917	18.2_5	0.5923*	16.3_1	0.5926	15.9_9	0.5924

*The current values in this column were only given to three decimal places by the Reichsanstalt, but since the corrections for difference in value of the standard cell amounts to 5 in the next place for the rotating lamps, and is the same for all the lamps, the mean is increased by 5 in the fourth decimal place.

the effect of such images is distributed over the entire horizontal zone, so that the resultant error would probably be small. A comparison of the lamps at 300 c. m. and at 125 c.m. revealed no appreciable differences, so that the measurements made at the Reichsanstalt are comparable with those made in England and France and at this Bureau.

The results of the determinations made in England were obtained by comparison with incandescent lamps, which in turn had been compared with the standard Harcourt pentane lamp of the National Physical Laboratory. This lamp is supposed to have an intensity of 10 British parliamentary candles, and therefore the intensities of the incandescent lamps verified for the Bureau are expressed in British candles. In France the comparisons were made against incandescent lamps which had been measured at the Laboratoire Central in terms of the Carcel lamp. By assigning to the Carcel lamp an intensity of 9.6 bougies décimales, a value obtained by Violle from a direct comparison with the platinum standard, the results are expressed in bougies décimales.

In Germany the comparisons were made against incandescent lamps which had in turn been compared against the Hefner amyl acetate lamp. The results are expressed in Hefner candles. Since at the Reichsanstalt the electromotive force of a Clark cell at 15° C. is taken as 1.4328 volts, instead of 1.4340 volts (the values used in England, France, and the United States), the voltages and currents of the incandescent lamps were modified accordingly, but in the following tables, for purposes of comparison, all voltages and currents are expressed in terms of the same units.

In Table I are given the complete results obtained for the individual lamps at the different laboratories, in the order in which the laboratories were visited. The first six lamps, B. S. Nos. 44, 45, 46, 49, 50, and 64, are the 50-volt stationary lamps, the remaining six, B. S. Nos. 4, 7, 8, 13, 30, and 40, are the 110-volt lamps that were standardized for mean horizontal intensity and are hereafter designated as the *rotating* lamps. The six lamps, three stationary and three rotating, which were left at the National Physical Laboratory, are not included in this table. They were used merely as a check on the constancy of the other twelve lamps.

In the first column are given the numbers of the lamps, in the second column the voltages at which the lamps were burned, and in the remaining columns the values of candlepower and current found at the respective laboratories. At the Bureau of Standards and at the National Physical Laboratory they were measured twice. The values given in the fifth and sixth columns are those obtained at the first visit to the National Physical Laboratory, but since for lack of time only a single set of readings was made, the results are not guaranteed by the National Physical Laboratory to a high accuracy. They are therefore omitted in the final comparisons of the units.

Table I reveals several interesting and important facts in regard to the present stage of development of the science of photometry. A comparison of the mean values of the stationary and rotating lamps before being carried abroad and after their return gives some idea of the constancy and portability of seasoned incandescent lamps as secondary photometric standards. The lamps were carried about for two months, were packed and unpacked five times, were burned in all about two or three hours, and yet the mean value of the six stationary lamps was found to have changed by less than 3 parts in 1000, while the mean value of the six rotating lamps apparently changed less than 1 part in 1000. It is not to be inferred from this that the lamps necessarily remained as constant as the results would indicate, since it is impossible to measure with certainty even the mean value of the lamps with an accuracy better than several parts in 1000. The constancy of the resistance of the lamp filaments as shown by the agreement between the mean current values is another indication of the constancy of the lamps and emphasizes the importance of accurate electrical measurements in the photometry of incandescent lamp standards.

A second interesting fact, on which some light is thrown by Table I, is the ultimate accuracy of photometric comparisons. Of course this accuracy depends largely on the nature of the sources to be compared, their color, relative intensity, constancy, etc. Moreover, any single observer with a particular set of apparatus may at any one time, or even at different times, obtain relative values between the two different sources to a remarkably high degree of accuracy. A very important question, however, is the accuracy with which different experienced observers using different apparatus can obtain the relative

values of two light sources under favorable circumstances.

This question is partially answered by Table I. The conditions of comparisons—at least for the stationary lamps—were as nearly ideal as could be realized with any known sources. The lamps were all of the same color (the voltages having been chosen initially to accomplish this); they were approximately of the same intensity, and those of each type burned at approximately the same voltage. The observers were experienced in photometry, and the measurements were made in laboratories of international reputation, but the apparatus and the methods of measurement employed were somewhat different.

In order to show the agreement among the different measurements the results are expressed in a more convenient way in Table II. Since the units of the different countries are not the same the values of the individual lamps are expressed in terms of the mean of the six lamps taken as unity.

In the first column are given the numbers of the lamps, the first six being the stationary lamps and the last six the rotating lamps. The next six columns contain the relative values of the lamps as determined at the various laboratories indicated at the head of the respective columns. The last column contains the mean relative values of the individual lamps, being the means of the values in the preceding six columns. If these mean relative values are taken as the true values of the lamps, by comparing them with the values in the other columns, an idea is obtained of the accuracy with which the individual lamps were measured in terms of the six standards. It is seen that the greatest deviation from the true value is only 0.7 per cent. for the stationary lamps and 1.2 per cent for the rotating lamps, whereas the average deviation of the measurements at any one laboratory is in no case as large as 0.3 per cent. for the stationary lamps, or 0.5 per cent. for the rotating lamps. The accuracy of reading is naturally somewhat less with the rotating lamps than with the stationary lamps, as the flicker for oval anchored filaments rotating at 180 revolutions per minute is quite perceptible and annoying, even to observers accustomed to it.

In comparing the relative values found at the different laboratories with the mean relative values it should be noted that the Reichsanstalt only certified the lamps to one-tenth of a Hefner candle, and therefore the relative values calculated from the Hefner candle values given by that laboratory are only significant to within several units in the last decimal place in Table II. Moreover, as stated above, the first values given by the National Physical Laboratory represent only a single set of readings, and consequently the agreement between the two columns of values given by that institution should not be compared with the agreement between the two columns of values found at this Bureau, and which represent the mean of a number of determinations.

TABLE II.

Relative Values of Individual Lamps in Terms of Mean.

Lamps	Bureau of Standards	National Physical Laboratory	Laboratoire Central	Reichsanstalt	National Physical Laboratory.	Bureau of Standards	Mean Relative Values
B. S. No. 44..	0.998	0.998	1.001	1.007	1.003	0.999	1.001
B. S. No. 45..	0.992	0.995	0.993	0.991	0.986	0.991	0.991
B. S. No. 46..	0.992	0.995	0.994	0.986	0.997	0.993	0.993
B. S. No. 49..	1.008	1.005	1.004	1.007	1.005	1.007	1.006
B. S. No. 50..	0.996	0.993	0.990	0.991	0.991	0.994	0.992
B. S. No. 64..	1.014	1.014	1.018	1.017	1.019	1.016	1.016
Means..	1.000	1.000	1.000	1.000	1.000	1.000	1.000
B. S. No. 4..	1.016	1.013	1.012	1.014	1.012	1.010	1.013
B. S. No. 7..	0.994	0.989	0.981	0.986	0.996	0.993	0.990
B. S. No. 8..	1.001	1.001	1.002	1.003	0.999	1.004	1.002
B. S. No. 13..	0.986	0.986	1.002	0.992	0.986	0.989	0.990
B. S. No. 30..	0.986	0.995	0.981	0.986	0.986	0.984	0.985
B. S. No. 40..	1.016	1.027	1.021	1.019	1.020	1.020	1.020
Means..	1.000	1.000	1.000	1.000	1.000	1.000	1.000

In order to compare the unit of the Bureau with those of the other laboratories, the values given in Table I are grouped in a more convenient form in Table III. In this table the unit of each laboratory is expressed in terms of the unit of the Bureau of Standards, except that the Reichsanstalt unit is expressed in terms of 0.88 times the Bureau unit. The ratios are given as obtained both from the stationary and from the rotating lamps, and it is interesting to note the differences between the two values. In every case the ratio obtained from the rotating lamps is lower that that obtained from the stationary lamps. This difference, which amounts to 0.7 per cent. at one of the laboratories, may be due in part to causes discussed in the paper referred to above on the errors incident to the rotating lamp method of measuring mean horizontal intensity. It may also be due in part to small errors in electrical measurements. Although all of the stationary lamps were of one type and all of the rotating lamps were of one type, these two types were not the same. The stationary lamps were 50-volt lamps, taking a current of 1.3 amperes, whereas the rotating lamps were 110-volt lamps, with currents of 0.6 amperes, so that the electrical conditions in the two cases were quite different.

It is seen from Table III that the unit of the Bureau is equal to $\frac{100}{88}$ of the Reichsanstalt unit to within the errors of measurement. Since the unit was originally obtained in this way nearly four years ago it indicates that the Bureau has maintained through incandescent lamp secondary standards, a unit which, compared with the unit of the Reichsanstalt, has not changed appreciably in that time. But though the Bureau has been able to maintain for several years a constant unit by means of incandescent lamp secondary standards, and could probably continue to maintain it in this way for an indefinite period, nevertheless the need of a suitable primary photometric standard is fully recognized and an investigation of primary standards will be undertaken in the near future.

It is evident from Table III that the value of the British candle obtained from the Hefner by the use of the fraction 0.88, which is supposed to represent the mean of the best determinations of the ratio, is not the same as the British candle defined in terms of the Harcourt (10-c.p.) pentane lamp at the National Physical Laboratory. The difference is about 1.5 per cent., according to the values given in Table III; but, as will be seen later, there is an uncertainty in this ratio amounting to several per cent. Before passing to a brief résumé of the recent determinations of the ratios of the three lamps recognized as standards in England, France, and Germany, it is desirable to call attention to the approximate agreement between the bougie décimale, the British candle, and the candle in use in the United States in the testing of electric lamps. The difference of about 2 per cent. is small compared with the accuracy usually obtained in industrial photometry, and no serious results would follow a compromise by which the three countries would agree upon a unit to be the same for all. This highly desirable end will become more difficult of accomplishment each year, as a higher accuracy of photometric measurement is demanded, and even now a change in unit of over 1 per cent. would be felt in the United States. Unfortunately the unit of Germany is so different from all the others that it would probably be impossible to agree upon a unit common to the four countries, but the ratio of the Hefner candle to the candle of France, England, and the United States could be accurately fixed.

The question of a uniform unit is to be distinguished from that of a uniform standard lamp in terms of which the unit is expressed. Thus at present the Carcel

TABLE III.

Values of Units of Different Laboratories in Terms of the Unit of the Bureau of Standards.

Units of Various Laboratories	—Values in Terms of B. S. Unit.— Stationary Lamps	Rotating Lamps	Means
Bureau of Standards unit	1.000	1.000	1.000
Reichsanstalt unit	1.001×0.88	0.996×0.88	0.998×0.88
National Physical Laboratory unit	0.987	0.981	0.984
Laboratoire Central unit	0.985	0.978	0.982

lamp in France has an intensity of 9.6 bougies décimales, and the Harcourt pentane lamp in England has an intensity of 10 British candles. Only in Germany has the standard an intensity of one unit, and even here in stating the intensity the word *candle* is affixed (Hefnerkerze). Of course it would be very desirable to adopt a common standard as well as a common unit, but the adoption of the unit is the more important of the two. As soon as an entirely satisfactory standard is presented, its general adoption will probably follow, and this is much more likely to result if the adoption of a new standard does not entail the adoption of a new unit. The Hefner lamp was recommended by the Geneva Congress as a secondary standard, but owing partly to the fact that the Hefner was not found as satisfactory in other laboratories as it had been found at the Reichsanstalt, and partly, no doubt, because of the different value of the unit, its general adoption did not follow. The Carcel continues to be used in France, and the Harcourt pentane lamp is coming into general favor in England.

In 1903 the commission which was appointed by the Paris International Congress of Gas Engineers to fix rules for the photometry of gas burners decided, upon hearing the report of Doctor Bunte, that the ratios of the three standards, the Hefner, the Carcel, and the Harcourt (10-c.p.) lamp, were not sufficiently well determined, and recommended that determinations of these ratios be made at competent laboratories in Germany, France, and England. The most probable values of these ratios, as given by Brunte, are reproduced in part in Table IV.

TABLE IV.

Most Probable Ratios of the Hefner, Carcel, and Harcourt (10-c.p.) Lamps as Given by Bunte.

	Hefner	Harcourt (10-c.p)	Carcel
Hefner	1.0	0.088	0.092
Harcourt (10-c.p.)	11.4	1.0	1.05
Carcel	10.87	.95	1.0

In response to requests from the commission new determinations of the ratios of the three lamps have been undertaken in laboratories of England, France, and Germany, and the results of some of these investigations have already been published. The values found at the Reichsanstalt are given in Table V.

The value of the Harcourt lamp is given for the atmospheric conditions adopted as standard at the National Physical Laboratory, which are a barometric height of 760 m.m. of mercury, and a humidity of 10 liters of water vapor in one cubic meter of pure, dry air. The value given for the Carcel lamp was 10.8 Hefner candles at a humidity of 8.8 liters of water vapor in one cubic meter of pure, dry air; but since the atmospheric conditions adopted as normal in Paris are the same as those normal to England, the value was corrected accordingly in order to make the results comparable in the various tables.

In France comparisons were undertaken both at the Laboratorie Central d'Electricité and at the Laboratoire d'Essais. The results of the comparisons at the former laboratory have been published in full, and in an appendix the results obtained at the Laboratoire d'Essais are summarized. At the Laboratoire Central the comparisons were made principally by measuring each lamp against incandescent lamps, but a few experiments were made in which the lamps were compared directly one against another. The results of these last experiments are combined with the results obtained at the Laboratoire d'Essais where but one method was employed, viz, that of comparing the lamps directly one against another. The values which will be submitted by the French laboratories to the International Commission are given in Tables VI and VII, in which the intensity of each lamp is reduced to the value it would have under the atmospheric conditions adopted as normal to the respective country.

In Table VI are given the results obtained at the Laboratoire Central by indirect comparison through incandescent lamps. In Table VII are given the means of two series of measurements made at the Laboratoire d'Essais and one series made at the Laboratoire Central, all by direct comparison.

TABLE V.

P. T. R. Values of Harcourt (10-c.p.) and Carcel Lamps in Terms of Hefner Candles.

Intensity of Harcourt (10-c.p) lamp	=	10.9 HK
Intensity of Carcel lamp	=	10.7 HK

TABLE VI.

Ratios Determined at Laboratoire Central by Indirect Comparison Through Incandescent Lamps.

	Carcel	Hefner	Harcourt (10-c.p.)
Carcel	1.0	10.76	1.0
Hefner	0.929	1.0	0.0929
Harcourt (10-c.p.)	1.0	10.76	1.0

The results of the comparisons made at the National Physical Laboratory have not as yet been published in full, but in the summary of the work of the Reichsanstalt for the last year, where the results of the measurements made at the Reichsanstalt are given, the values given in Table VIII are recorded as having been determined at the National Physical Laboratory. The value of the Carcel lamp is corrected to the values it would have under normal atmospheric conditions.

TABLE VII.

Ratios Determined at Laboratoire d'Essais and Laboratoire Central by Direct Comparison.

	Carcel.	Hefner.	Harcourt (10-c.p.)
Carcel	1.0	10.73	0.991
Hefner	0.0932	1.0	0.0933
Harcourt (10-c.p.)	1.009	10.72	1.0

TABLE VIII.

N. P. L. Values of Harcourt (10-c.p.) and Carcel Lamps in Terms of Hefner Candles.

Intensity of Harcourt (10-c.p.) lamp = 10.95 HK
Intensity of Carcel lamp = 10.68 HK

In the determinations of the ratios made at the various laboratories, of necessity different lamps were employed. At each laboratory the respective lamp or lamps recognized as the standard of the laboratory were probably used, but at the Laboratoire Central, for example, the Hefner and Harcourt (10-c.p.) lamps that were used were not the particular lamps that are taken as the standards of the Reichsanstalt and the National Physical Laboratory, respectively, so that any lack of reproducibility of any of the standards might cause differences in the ratios determined at the different laboratories. It is interesting, therefore, to compare these ratios with those calculated from the values assigned by the various laboratories to the twelve incandescent lamps of the Bureau of Standards. The ratios calculated from the incandescent lamp measurements are given in Table IX. In making the computations the intensity of the Carcel lamp was taken as 9.6 bougies décimales, the Harcourt (10-c.p.) lamp as equal to 10 British candles, and the Hefner lamp as equal to 1 Hefner candle.

TABLE IX.

Ratios Calculated from Intensities Assigned to B. S. Incandescent Lamps.

	Harcourt (10-c.p.)	Hefner.	Carcel.
Harcourt (10-c.p.)	1.0	11.19	1.043
Hefner	0.0893	1.0	0.0932
Carcel	0.959	10.73	1.0

It would seem that the values obtained through the incandescent lamps are in some ways the more accurate ratios of the *units* of the various countries, because the primary standard of each country is operated under the usual conditions by the most experienced observers with the respective lamp, whereas in the direct comparisons different lamps are used, and the conditions of operation in the different countries may be slightly different from the conditions normal to the laboratory in which the respective lamp is a standard.

The ratios obtained at the various laboratories, together with the values obtained through the Bureau of Standards incandescent lamps and the best previous values, as given by Bunte, are summarized in Table X. It is seen from this table that the best agreement is obtained in the ratio of the Carcel lamp to the Hefner lamp, whereas discrepancies amounting to 4 or 5 per cent. occur in the other ratios. The most important result to engineers of the United States is the discrepancy in the ratio of the Hefner candle to the British candle as given by the Harcourt (10-c.p.) lamp. The value given by Bunte as the best previous ratio is 0.88, and so is the same as that recommended by the American Institute of Electrical Engineers and adopted by the Bureau. This value, however, is 2 per cent. different from that obtained through the Bureau of Standards incandescent lamps, and 5 or 6 per cent. different from the values found at the various laboratories. If, therefore, the British candle be taken as one-tenth the in-

TABLE X.

SUMMARY OF RATIOS OF HEFNER, HARCOURT (10-C.P.), AND CARCEL LAMPS.

	Harcourt (10-c.p.). Hefner.	Carcel. Hefner.	Harcourt (10-c.p.). Carcel.
Reichsanstalt (using an electric comparison lamp)	10.9	10.7	1.02
Laboratoire Central (using an electric comparison lamp) ...	10.76	10.76	1.00
Laboratoire Central and Laboratoire d'Essais (direct comparison)	10.72	10.73	1.009
National Physical Laboratory	10.95	10.69	1.024
Ratios computed from Bureau of Standards incandescent lamps	11.19	10.73	1.043
Best previous values (Bunte)	11.4	10.87	1.05

tensity of the Harcourt (10-c.p.) pentane lamp at the National Physical Laboratory, according to the values assigned the Bureau of Standards incandescent lamps, it is 2 per cent. different from the candle in this country obtained from the Hefner lamp by using the ratio 0.88. If the British candle be taken as one-tenth the intensity of any Harcourt (10-c.p.) lamp, it would seem from Table X to be different from the candle in this country by 5 or 6 per cent. Whatever the amount of the difference, it would seem that the candle in use in the photometry of electric lamps in the United States is sufficiently different from the British candle, as obtained through Harcourt (10-c.p.) pentane lamps, to justify defining the unit obtained through the Hefner by use of the ratio 0.88 as the *candle* instead of the *British candle*. It is hoped, however, that the suggestion made in a previous paragraph in regard to an international *unit* may be carried out, and that by a constant intercomparison of the standards of the different countries by the interchange of electric incandescent lamps the unit may be maintained uniform.

Magnetite Lamps for Street Lighting

From Municipal Engineering.

In a supplement to his report on the cost of constructing and maintaining a municipal light plant submitted to the Board of Works of Newark, N. J., Mr. Frederick O. Runyon gives the following data.

By means of numerous tables, Mr. Runyon demonstrates that the average cost per arc light with the "magnetite" lamp in use, and services from a municipal plant for a ten-year period would be $59.67, as against $65.22, the estimate with the present type of lamp, and $70, the rate offered by the Public Service Corporation.

While increasing the item of overhead construction greatly, the report shows that the adoption of the new lamp will have the effect of reducing the capacity of the plant required 47 per cent., decrease the amount of coal necessary to approximately the same extent, and to make the labor required less. Besides increasing the cost of the outside plant, the introduction of the lamps would also have the effect of adding to the money necessary to pay for renewals.

Mr. Runyon estimates the cost of a plant at the old Belleville pumping station at $821,000, as compared with $832,650, the cost as contained in Mr. Runyon's report submitted October 8. In the items that go to make up this total the cost of power station and stack is reduced from $225,000 to $180,000; the estimated cost of boilers, stokers, economizer and steam fitting from $118,000 to $90,000; turbo-generators from $98,000 to $84,000.

With the new lamp, overhead construction charges will cost $167,000 as against $96,000, the original figures. The cost of switchboard and electrical apparatus is increased from $17,000 to $22,000. The cost of a plant at Belleville, exclusive of engineer's fees, is $782,000, as compared with the old estimate of $793,000.

Mr. Runyon says the cost of boilers, economizers and steam fitting is reduced because the magnetite lamp does not require the conversion of so much energy as the ordinary lamp. The cost of the power station and stack is less because they will be smaller than originally contemplated, while the outlay needed for switchboards and other electrical apparatus is lower because of the additional equipment of rectifier panels.

The cost of overhead construction is increased by an amount equivalent to the difference between the cost of "magnetite" lamps and the ordinary lamp. The latter type take 7.5 amperes at 80 volts, as against 4 amperes at 80 volts consumed by the new lamp, which cost about $50 apiece. The present arc lights cost $18 apiece.

Foreign Items

The Influence of a Discharge on the Intensity of a Luminous Flame

By C. F. Lorenz.

From Physicalische Zeitschrift.

He states that the luminosity of a flame increases when through the latter is passed a discharge of an alternating current of an induction coil. The phenomenon is especially striking with an acetylene flame. As previously pointed out by Semenov, in connection with his experiment with a spark discharge through a gas flame, a deposition of carbon is formed on the conducting points of the electrodes. The deposition of carbon may, however, be avoided by surrounding one of the electrodes with a hot and non-luminous envelope about the flame. In the author's experiment the two electrodes were disposed following the axis of an acetylene flame, one below and the other above. The electrodes were formed of yellow brass rods of 3 mm. in diameter and terminated with blunt points. Non-purified acetylene gas was used. The frequency of the current feeding the primary coil was sixty. The photographed image taken with the aid of a revolving mirror shows that the flame alternately shortened and turned more luminous with each discharge. The augmentation of the luminous intensity grew sufficiently with the intensity of the secondary current (up to about 40 milliamperes measured with a thermic ampere meter), then it remained constant. The examination of the photographic proofs showed beside this that the luminous intensity in the vicinity of the electrode is more pronounced when this electrode has a determined polarity than when the polarity is reversible. The photometric measurements of the luminous intensity in comparison with an incandescent lamp show that this intensity equals 7.5 candles in the absence of the current and grows to 38 candles when the intensity of the discharge-current reaches 42 milliamperes. The intensity variations of luminosity are essentially proportional to the intensity of the current within these limits. However, the luminous intensity remains constant when high discharges are used. (The author went as high as 65 milliamperes.) In this experiment the discharges were produced by two transformers in series allowing the increase of tension to 4,000 volts. The measurement of the primary energy consumed at the moment of maximum intensity gave 122 watts. The gain in horizontal luminous intensity was then 30.5 candles, a consumption of energy per candle increase being about 4 watts. The measurement of the potential difference between the electrodes, deducted from the indications of a voltmeter connected with the primary coil showed that this difference was growing at the same time with the intensity of the current of the discharge and passed through a maximum in the vicinity of 3,000 volts for an intensity of 11 milliamperes. The author also studied the action of a direct current produced by a number of small dynamos in series capable of producing 2,500 volts. In this case, also, an increase of luminosity was noticed, and in addition to this the current added steadiness and almost silence to the flame. We have to add that the passage of an alternating current also enriched the flame with ultraviolet rays.

The increase in luminosity may find an application in the lighting industry.

However, we should not forget that up to this point this increase is far from being economical as it is connected with a consumption of four watts per candle.

Sensitiveness of Incandescent Gas Burners

From Journal of Gas Lighting.

According to a short note in "Acetylen in Wissenschaft und Industrie," published a few weeks ago, attention has been called in Germany to the manner in which incandescent acetylene gas-burners sometimes respond to noises in the room where they are alight. The specific case mentioned is one where a hotel supplied with acetylene from a village works was lighted with a number of incandescent burners, one of which jumped very seriously whenever a bunch of keys was shaken in the restaurant, or the door of the oven was violently slammed. On examination, the burner itself proved to be in perfect condition; its jet was not obstructed, and it was consuming gas which contained no air or dust. The other burners on the same service remained perfectly steady. In discussing the cause of the phenomenon, the writer in the German paper gives what is doubtless the

correct explanation—viz., that in certain circumstances the mixture of gas and air traveling through the tube of a burner, and changing in speed and pressure according to the conditions locally prevailing, may be disturbed in its steady onward motion by sound composed of vibrations of one or more particular wavelengths, until the gaseous mixture issues from the orifice in a series of jerks, so that the flame changes in shape and affects the manner in which the mantle is glowing. In the German writer's opinion, the trouble is aggravated by dust or any solid particles in the gas, which tend to partially block up the nipple and so reduce the pressure after it. He adds that similar trouble is occasionally met with in coal-gas burners, but is much less common and less conspicuous.

As a matter of fact, however, the phenomenon of sensitiveness to sound is fairly common among incandescent coal-gas burners, especially such as have been erected by a member of Uncle Podger's family. Any domestic incandescent gas-burner, if not already slightly sensitive to sound, can easily be set to be so, generally by checking the gas supply to a point at which the mantle emits rather less than its proper quantity of light. The phenomenon is probably fairly common, as already stated; but when it arises, the jumping of the light is ascribed by the non-technical observer either to an alleged momentary change of pressure in the service, or to mechanical vibration of the pendant or bracket on which the burner is supported, caused by some heavy article falling in the house or by a person walking about the room overhead. It is rather strange that explanations of the latter kind are frequently offered by intelligent people. If the jumping of the light were brought about in the manner stated, the jumping would be irregular, or, if it were due to variations in the service pressure, would occur at slow, regular intervals synchronizing with the change of the chamber from which the gas was issuing in its passage through the house meter.

A little patient investigation of an ordinary upturned "C" burner, or more particularly a "Kern" burner, when the supply of gas is checked, will show that the phenomenon is purely acoustic, and has no connection whatever with any mechanical agitation. The flame alters in shape for an instant in sympathy either with any noise produced in the room, or with noises of a certain character; and the alteration in shape causes the mantle to glow with less than its normal brightness during the period of the disturbance. The flame may, for instance, respond to the shrill jingle of knives and forks touching a dinner plate, but may ignore a bass sound of greater intensity. Sometimes the flame may respond to a rather deep sound and ignore shriller ones. In rare cases a flame may be sensitive only over limited range of the musical scale, and in still rarer cases may respond in preference to one or two notes only.

The Luminosity of Acetylene Gas in Relation to the Mode of its Use, its Consumption and Pressure

Report presented to the International Committee for Carbide and Acetylene.

By R. Granjon, Paris.

From Zeitschrift für Calciumcarbid-Fabrikation.

The luminous intensity of illuminating gases is generally expressed in units of volume to be consumed in order to attain a unit of light. We, for instance, speak of the luminous intensity given by X liters for Carcel hour, l. e., this volume of acetylene will furnish in an hour the same quantity of light as the light unit known under the term Carcel (= 10.8 H. C.).

The use of acetylene for illumination was proposed, because it was recognized to excel all other illuminating gases and because the ratio between its cost of production and its luminous efficiency is a favorable one.

The first publication concerning acetylene claimed for it a luminous intensity fifteen to eighteen times that of the mineral coal gas. These claims were certainly incorrect as the luminosity of an illuminating gas varies with its chemical composition and even the burners used in its consumption. In the course of his investigations, Lewis arrived at the conclusion that 1 (c.m.) of acetylene furnishes 168 Carcel hours, of which follows approximately a consumption of six liters per Carcel hour.

Older investigators also that that Violle in his labors on light intensity assumes that 5.6 liters acetylene give one Carcel hour, that 5-10 Carcel burners generally consume 7 liters per Carcel hour, while weaker burners consume 8 liters.

The last figures are found in almost all

publications on acetylene gas, and the industry adjusts itself to these figures. However, some experimenters, who were not satisfied with the data concerning the luminous intensity of acetylene gas and took into consideration the variations between different acetylene burners and studied the cost of light units furnished by other sources of illumination arrived at conclusions considerably at variance with those generally accepted. I noticed when attending to various photometric experiments with acetylene flames in 1907 at the University of Aux-Marseille, that the luminous intensity of acetylene was subject to wide variations and that its luminous intensity depended on the kind of burner used, from the length of time it was in use and from the gas pressure. I therefore expressed in the *L'Acetyleniste* 61.10, July, 1901 ("Le Débit beuleurs") and 66.25 September, 1901, the view that it was desirable to determine the pressure peculiar to each type of burner in use, as the light effect varies even in burners of the same type, according to the hour consumption. Similar opinions were expressed by German and Austrian observers. However, these really extraordinary variations in the light efficiency of acetylene under different conditions was not emphasized strong enough. Ed Fouché also pointed out in his contribution to the IV. International Acetylene Congress, entitled "Photometrie and Acetylene," the mentioned variations in the light effect and cited figures forcing the attentive readers to take them into consideration.

As the people engaged in the acetylene industry are in the favorable position of being able to apply the achievements of scientific and experimental research, I considered it as an interesting and useful task to establish to what extent and between what limits the useful effect changes according to the kind of burner in use and the pressure applied. I arrived at the following conclusions through the study of publications devoted to the verification of these data and their critical comparison, and also through my own investigations in that field:

A.—Type burner: Varying useful effects are given by burners of the same consumption and even when favorable pressure is applied according to their construction.

Example: A divided burner claimed to consume 20 liters in an hour (Konjugister Brenner) used up at a favorable pressure 11.8 liters per Carcel hour. A Manchester burner, of the Bray type, of the same hour consumption furnishes a Carcel hour with 7.1 liters (average value of Fouché, Mauricheau-Baupré, Perrot and Grandjon).

B.—Gas-consumption: The useful effect when burners of the same type are used varies with the gas consumption, and ratio of the luminous intensities, in extreme cases, even when only favorable pressures are applied, is 1 : 2.

Example: The most favorable light efficiency of a ten liter divided burner is 13.1 liters per Carcel hour; the same burner with a 20 liter consumption uses only 11.8 liters more and the 30 liter burners only 6.2 liters per Carcel hour (these data are derived from the works of the previously mentioned experimenters).

C.—Pressure: The light effect changes considerably with the pressure when burners of the same type are used or even various types.

Examples: The Manchester burner and the divided burners give the best efficiency at a pressure of 5.7 cm. for the divided burners, according to the consumption, a pressure 7-11 cm. and for the jet burner of 10-30 cm. is required. Even when burners of the same type are used a different pressure is required at different consumption. Bray burners of 20 liters

consumption	5 cm. pressure
Manchester burner of 40 liters consumption ..	6 " "
Divided burners of 20 liters consumption ..	7 " "
Divided burners of 30 liters consumption ..	10-11 " "

With the change of pressure there is a marked change in the luminosity in the same burner.

For instance, a 20 liter Manchester burner at a pressure of 5 cm. consumes 7.1 liters acetylene gas per Carcel hour; at a pressure of 8 cm., 9 liters; at a pressure of 10 cm., 9.6 liters, and at a pressure of 11 cm., 10 liters, the 40 liter Manchester furnishes a Carcel hour with each 6.6 liters, at 6 cm., and with 7.5 liters at 10 cm. pressure. The light efficiency of the 20 liter divided burner changes at the same ratio according to the pressure of 7.10 or 12 used. The 30 liter divided burner gives the highest efficiency as 11 cm. The light intensity is diminished by lowering as well as increasing the pressure. The following table represents the useful effects of some acetylene burners.

The conclusions derived from this table are as follows:

1. The most favorable efficiency is 6.1 liters per Carcel hour.

2. Burners with the lowest useful effect consume at the most favorable pressure 14.8 liters per Carcel hour.

3. Burners under 10 liters hourly consumption use up at least 11 liters per Carcel hour.

4. The divided burners give a high useful efficiency in case the hourly consumption amounts to at least 25 liters and the pressure to 10-11 cm.

5. The Manchester burner (Bray burner) gives a high efficiency when it reaches an hourly consumption of at least 20 liters and the pressure is 5-6 cm.

6. At a low gas consumption the single jet burners shows a higher efficiency than the Manchester burner or divided burner.

7. The Manchester Bray burner has one-third higher consumption when it burns at a pressure lower than that necessary for the divided burner.

8. The appropriate pressure for divided burners of 25, 30 and 35 liters consumption is about 3 cm. higher than that for 10, 15 or 20 liter burners.

Name of burner.	Hour consumption in liters.	Best effect at a pressure of	Acetylene consumption per Carcel hour.
Gabel burner	10	7 cm.	13.1 ltr.
" "	20	7 "	11.8 "
" "	25	10 "	9.2 "
" "	30	10-11 "	6.2 "
" "	35	9-10 "	6.1 "
Bray burner	6	5 "	14.8 "
" "	20	5 "	7.8 "
" "	40	6 "	6.6 "
Single jet burner.	5	14 "	12.7 "
" " " .	8	12 "	11.1 "
Divided burner ..	30	5-6 "	7.5 "

Gas and Electric Light in Fog

From Journal of Gas Lighting.

One effect of the inquiry respecting the loss of the steamship *Suevic* at the Lizard has been to recall some reminiscences of the old controversy respecting the merits of different illuminants for lighthouses. As our readers are aware, Sir James Douglass and Mr. John R. Wigham, who took leading parts in the dispute as advocates respectively of electric light and gas, are both dead; but their representatives have shown a commendable desire that justice should be done to their memory and to the causes they favored. Mr. Joshua W. Edmundson, a nephew of Mr. Wigham, who himself assisted in the South Foreland inquiry, contends with great justice that the wreck of the *Suevic* has demonstrated the truth of his uncle's contention that electricity as an illuminant is not to be compared with gas or oil when the weather is foggy. It is a somewhat costly lesson, and would have been even more so if circumstances had not favored the landing of the passengers and crew. Mr. Edmundson points out that since the South Foreland experiments were carried out no important headlands have been found on which to place an electric light except that of St. Catherine's, in the Isle of Wight, which received the apparatus used experimentally at the South Foreland. The Lizard light, which, as already pointed out in the *Journal* (*ante*, p. 288), cannot be discerned, even when the light of farmhouses is visible, is a new and powerful light, put up a few years ago in place of two electric lights of inferior power. But though more powerful, the light is apparently not more effective at times when it is most needed. One interesting fact recalled by Mr. Edmundson is that Mr. Wigham first came to the conclusion that the electric light is lost in fog, more than either gas or oil, 35 years ago, when he erected the signal-light on the Clock Tower at Westminster, in competition with an electric arc lamp. The gas and electric light were tested at a distance of eight miles on a foggy night, with the result that the gas was visible and the electric light could not be seen.

Commercial Engineering of Illumination

Personal Mention

On April 29th the Moore Electrical Company, of Newark, New Jersey, sent via the Hamburg-American Liner *Deutschland,* two men and apparatus for two installations of the Moore light in the largest automobile garage in Europe, located in London. This is especially interesting because it is the first foreign installation of the Moore light.

Williams & Bernhard Company, Commercial Engineers and Sales Agents, opened their offices in St. Louis, Mo., on April 15. Their purpose is to afford manufacturers of electrical apparatus and accessories expert representation, and to act as general sales agents, marketing the entire output of their principles, or as local sales agents in the St. Louis territory for other manufacturers who wish to establish, through them, the equivalent of their own offices in that district.

Mr. Williams is too well known in the field of electric lighting to require any extended introduction on our part, having been connected successively with the Columbia Incandescent Lamp Co., the Bryan-Marsh Co. and the Sawyer-Mann Electric Co., with headquarters variously situated in St. Louis, Chicago, Boston, and New York. Mr. Bernhard is a native of Holland, where his father owns and operates a large ship-building company. He is a graduated mechanical engineer, with a large practical experience. The combination of thorough technical knowledge, with successful experience in salesmanship, thus afforded in the new company, should at once give it an established place among the leading engineering and selling organizations of its section.

The annual Conference of Salesmen of the Columbia Incandescent Lamp Co., was held at the office and factory in St. Louis, on May 23, 24 and 25. The usual custom was followed of having business sessions during the day, and various forms of entertainment in the way of dinners, theater parties, etc., in the evening. We understand that the conference was most successful in every respect, the various representatives being highly enthusiastic over the prospects for the coming season, and the company equally satisfied with the excellent work of its representatives in the past.,

We take pleasure in congratulating both the company and its representatives on this occasion. The idea in itself is a most excellent one, as it tends to keep enthusiasm up to top notch, and enthusiasm is to the salesmen what voltage is to an incandescent lamp.

We wish the Columbia Company the full measure of success which its long efforts to give patrons and employees a "square deal" deserves.

Organization and Conduct of a New Business Department Suitable for Central Stations in Cities of 50,000 Population and Under.

By John G. Learned.

Experience has taught us that wiring for a porch light at cost has been the means of securing on our service a very large number of customers. Sixty customers were secured out of 275 people approached by a circular letter. This you will admit is a very large percentage. The cost of burning a porch light is nominal and rarely runs over 75 cents or $1.00 per month. At first sight you may think it does not pay to put in service for one lamp. It does. It is only a short time before the entire house or part of it is wired.

The next proposition for old residences is to wire for six outlets at a concessional price of one-half or the actual cost, the outlets mentioned to be placed as per direction of the consumer, with restrictions according to the conditions existing in your particular locality. Six outlets will give the customer a chance to try the light and invariably result in putting on additional lights. This proposition was offered to about 600 old residents, out of which 53 responded and 23 were secured to the service. This is considered a small percentage.

The average man is always ready to accept something which apparently is free, therefore for a period of three months make a standing offer to allow $25.00 worth of current free to any resident who wires his home for a certain number of lights during that period, said free current to be used within a specified time. The results from this offer were very gratifying, in fact flattering, as about 40 old houses which before making the offer were almost impossible to reach, readily came on the service.

The following very attractive proposition was offered to a selected list of about 200 residents who occupied their own homes. (Circular letter sent to above mentioned selected list.)

"To the residents of your section who own their homes, and who have considerable investment in them we are making the following very attractive offer:

"We will bring our lines to your premises, install our service and at your direction wire for not to exceed six single electric light outlets, entirely free of cost.

"We would suggest a light for the porch, controlled by a switch in the vestibule; one in the library for a reading lamp; one in the *dark clothes closet* will eliminate all possible danger of *fire*, and one in the furnace room controlled by a switch at the head of the stairs.

"All we wish is that you agree to use electricity for burning the lamps for two years, and that your monthly bill be at least $1.00

"It is our intention to make ONE HUNDRED of these installations, and the first one hundred applications we receive will obtain this wiring free of cost. This involves an expenditure of a very considerable amount of money on our part, and if at any time you conclude to equip your premises throughout for the use of electric light, it will make a very material saving in the expense.

"The enclosed postal card with your name and address, mailed to us, will bring our representative, who will be pleased to give you full information on the subject.

"Yours very truly,

"Contract Agent."

Seventy responded to this letter, and as a result the C. S. was successful in securing 47 old residences, all of which are considered very good customers. Their bills average about $3.50 per month, this average taken for a period of eight months. The average cost of wiring each of the above houses mentioned was about $20.00.

The foregoing are a few of the schemes which have been used with success in obtaining old houses on the system. A new proposition will always bring in a few of the old residences.

Most towns have a few tenement and flat buildings. It is sometimes a task to obtain the lighting of these buildings. It is a good policy to have them wired at any cost, having the halls wired separately from the flats, this being done in the first place, the rest is easy. As a rule tenants in flat buildings are very good customers, easy to secure and easier to hold. In order to permanently secure and hold the hall lighting, the C. S. shall allow the owner a special commission in the form of a discount on his hall lighting, this discount depending upon the number of customers in the building which use C. S. service. As a result of this proposition the owner or agent of the building is instrumental in having a backward tenant use light. This proposition also applies to office buildings. Right here I will say that it is important for the district solicitor to win the heart of the jani-

tor of the building, as he is of great value to the C. S. in securing flat customers, as he is on the ground with the prospective customer at all times and a word from him goes a long way in convincing the prospect that he should use electric light.

The problem of securing store business we are ready and willing to admit is a very difficult one. Many schemes and methods have been tried. The writer suggests, however, that to start the wayward store customer using electric light by first getting him interested in lighting his windows. To him window lighting is a matter of experiment. In order to show him that it is not an experiment with you, but an absolute necessity, and that you have confidence in the fact that he will continue to use electric service, wire his windows free of charge. You may hesitate to do this. Don't. It is good business. It is not only an advertisement for the store-keeper, it is also the best advertisement the C. S. can obtain. The income is good, as a storekeeper as a rule is a long hour user. Induce him to use the light in his windows when he has closed the store. In order to sell goods you must show them, and show them under the most favorable conditions. This may be done by using electric light. Teach him the why and how, how to light windows, and why, because it is his best advertisement. Impress upon him the necessity of showing his goods and show them as before mentioned, under the most favorable conditions. Space will not permit giving an illustration of the modern methods of window lighting. Some differ, though the writer considers reflector window lighting the most advantageous. The lighting of the interior of the store follows as a natural result.

In those districts where you find that it will pay to maintain patrol service, install arc lamps on a flat rate basis. Furnish the standard arc lamps, do the wiring, both for flat rate service and also on meter basis, with a special minimum monthly guarantee. Experience has taught us that arc lamps are most satisfactory for space lighting and that a large amount of well paying business has been secured by doing free wiring. Special attention should be given to the distribution and maintenance of arc lamps.

One branch of the electric lighting business too often neglected is signs. Do not hesitate pushing it. It means big revenue and is a good advertisement. Start out right. Hang a sign in front of your office, also one or two in another portion of the town to advertise your business. If you show the public that you believe in signs they will follow suit and you will find that the sign business will grow. Adopt a standard sign. There are several companies that now make a specialty of furnishing Central Station companies signs at a reasonable price, which may be used time and time again. Signs furnished free to the customer have been means of securing a vast amount of business. By free the writer means that the signs are furnished, hung and connected without expense to the customer, under a special contract whereby he agrees to use a certain amount of current each month. If patrol service is convenient, furnish the sign on patrol basis, if not, on meter basis.

It is marvelous to think of the attempts some of the C. S. companies make in the advertising line in order to secure new business. Most of the small companies are inactive in the advertising field. Why they should remain dormant in this line is a mystery. Look around you, Mr. Central Station Manager. All the department stores and merchants are awake, up and doing. Perhaps you sit idly thinking that business will come to you. This should not be done. You are selling a commodity similar to that of your neighbor. Put it before the public, show it to them, keep it in sight of the public all the time. The question is, how to impress upon them the fact that you are doing business. There are many methods of doing this. First and easiest will be in using the newspaper as an advertising medium. Secure a small space in a local paper. Change your adv. periodically. Tell the public in a clean, clear and concise way of your business. Each advertisement to be a story, not too long, and should bring out a new point each time relative to the advantages obtained in using your service. As a rule the newspapers are always ready and willing to accept copy. Why not make it electrical, readable, interesting, in the form of a story, telling the uses and advantages of electricity. Should any Central Station manager desire copy of the matter used by the writer in this manner, same will be gladly forthcoming upon application.

Miscellaneous News

ALBANY, N. Y.—The Assembly Committee on Electricity, Gas and Water Supply has introduced a bill in regard to the standard of illumination and purity and pressure of gas supplied in cities of the second class. The bill is the result of the investigations leading up to the Hammond bill for Syracuse. It was clearly shown that the absence of any comprehensive standard was an injustice to the gas consumers throughout the State which had prevailed ever since gas was first introduced commercially. The companies could give the consumers whatever they pleased. The bill also fixes definitely how tests shall be made, based on the experience of Syracuse. Otherwise the standards would mean nothing. The bill provides: The gas furnished or supplied by any corporation in such cities shall be free from sulphuretted hydrogen, to be determined by exposing for thirty seconds a slip of white paper saturated with acetate of lead to a jet of gas flowing about five feet per hour, and each 100 cubic feet shall not contain more than ten grains of ammonia nor twenty grains of sulphur. The maximum illuminating power required and the minimum illuminating power permitted shall be as follows: If a coal gas, sixteen candles; if a mixed coal and water gas, eighteen candles; if a carburetted water gas, twenty candles. The test for illuminating power shall be made with gas obtained from a service pipe or main located at a distance of not less than a mile or more than one and a half miles from any distributing holder, using on a basis of consumption of five cubic feet of gas per hour, for coal gas and mixed coal and water jets containing more than o per cent. of coal gas an "F" Argand burner, and for mixed coal and water gas and for meter gas a seven-foot flat flame burner. The minimum pressure of gas so furnished or supplied which shall be permitted in any service main shall be sufficient to balance a column of water one and one-half inches in height. The maximum pressure allowed shall be an amount sufficient to balance a column of water three and three-quarter inches in height, plus an allowance at the rate of one inch for variations of each 100 feet of increase in attitude in the distributing system between the holder and the point of consumption except that no maximum pressure shall be prescribed in service mains the pressure of gas from which is regulated by service governors, supplied and maintained without charge to the consumers.

ALBANY, N. Y.—Governor Hughes has signed the bill of Senator Grattan fixing $1 per 1,000 cubic feet as the rate to be charged for illuminating gas in the city of Albany. The State Commission of Gas and Electricity has issued an order fixing standards of purity, power and pressure of gas in cities and towns outside of New York City. The standards follow those in the bill of the Assembly Committee on Electricity, Gas and Water Supply, affecting cities of the second class. The illuminating power of gas is as follows: Coal gas, 16 candles; mixed coal and water gas, 18 candles; water gas, 20 candles. The power test must be made at least a mile from the distributing holder. The Assembly bill affecting second class cities has been amended in minor details, but there is some talk of making it apply to the entire State. The water gas standard in New York City is now 22 candle-power, but there is no penalty unless it falls below 20, and that is about the standard maintained.

NEWARK, N. J.—James M. Seymour, Newark, has complete plans for a municipal electric plant to be constructed at the City Hall, at a cost of about $30,000. The specifications call for three 100-kw. generators. Michael J. McGowan, Jr., is chairman of Lighting Committee.

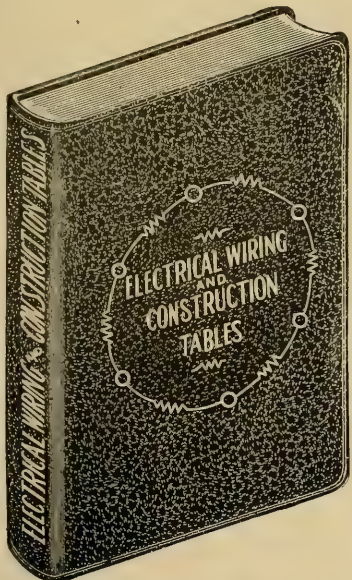
BUFFALO, N. Y.—Pursuant to a resolution adopted by the Common Council and approved by Mayor Adam, the Buffalo Gas Company began removing Welsbach lamp heads from Delaware avenue, selecting that street as the starting point for the work throughout the city. The 1,497 lamp heads of the boulevard character are to be replaced by the old style flat burner owned by the city. Bids for supplying new Welsbach lamp heads have been offered by the Sun Vapor Light Company, of Canton, Ohio, a subsidiary of the Welsbach Company, and the Cleveland Street Lighting Company, the first named company offering to furnish the lamps for $10 apiece a year and retain the ownership of them, the Cleveland company agreeing to furnish the lamps to the city for $10.45 a year, the city to become owner at the expiration of five years.

NEW YORK, N. Y.—Attorneys for the Long Acre Electric Light and Power Company are busy preparing applications for space in the subways throughout the theater district preliminary to the extension of its service. The company says that it has ample funds to prosecute the work vigorously, as $1,000,000 worth of bonds have already been placed. It promises to furnish light at a third of the present rate. "We are on the verge of a new era in electric lighting, particularly in New York City," said Walter H. Knight, engineer of the Manhattan Transit Company. "The Long Acre Electric Light and Power Company proposes to take the lead in installing all these improvements. Gas is becoming obsolete as an illuminant, and if it were not for the Welsbach light it probably would have been put to the rear some time ago except in provincial districts. The cheapest form of illumination provided by the companies in this city at present is the Welsbach light. There are later and more up-to-date appliances which are also far cheaper that will be installed by the Long Acre Company. We are not ready as yet to disclose the full extent of our plans, but we might call attention to the Tungsten lamp, which is cheaper than the Welsbach. It takes only one-half as much current as the present Edison lamp. I think it will be but a short time before the cost can be cut to one-quarter of the present rate."

ST. LOUIS, MO.—Supervisor of City Lighting Carter will suggest to the B. P. I. shortly that an ordinance be prepared authorizing his department to test the electric meters of the lighting companies as gas meters are tested. As the matter stands the people are compelled to accept meters furnished by the electric lighting companies as correct. As a first step toward a municipal lighting plant, Harbor Commissioner Whyte will submit to the Board of Public Improvements a bill authorizing that body immediately to advertise for bids for lighting the city at the expiration of the present contract in 1910. The bill has the approval of Mayor Wells. If low bids are not obtained, it is proposed to begin legislation looking to the establishment of a municipal plant. The present lighting contract is for $550,000 a year, with $25,000 added for lighting public buildings. Supervisor of Lighting Carter has estimated that lighting the city by municipal plant would cost $512,980, while the plant would cost $2,523,000.

TOPEKA, KAN.—Mayor Green thinks the city should have an electric light commissioner to make an equitable distribution of the new street lights that are to be installed. If the city gets 500 arc lamps, either on a contract or by rebuilding the municipal electric light works, it will mean a complete rearrangement of the street lights. The mayor does not want this rearrangement left to the council. "The only way in which we can get a satisfactory distribution is to have a commissioner to do the work and take the responsibility," he said. "The commissioner will not have to be a permanent officer. He will merely have to be appointed for a few weeks at the time the new lights are being installed. After the 500 lamps are put up it is not likely that there will be many additions for a couple of years, and the city will not have to keep a man employed to look after the arrangement of new lamps. The distribution of street lamps under the new system should not be handled in the council. Each councilman would pull for his own ward, and the interests of the city at large would be of secondary importance. We will need a man whose business is to take up the matter in a scientific way, study the needs of the city at large, and put the lamps where they will do the most good. The street lights in Topeka have always been inequitably distributed. In some parts of the city there are more lamps than are necessary, while other districts are left in darkness. We should not get started wrong the first thing when we institute a new system."

Macbeth-Evans Glass Company,
Pittsburgh,
Manufacturers of all kinds and colors of
Illuminating glassware,
Alba glass for diffusion,
Thermo glass for high temperature lamps.



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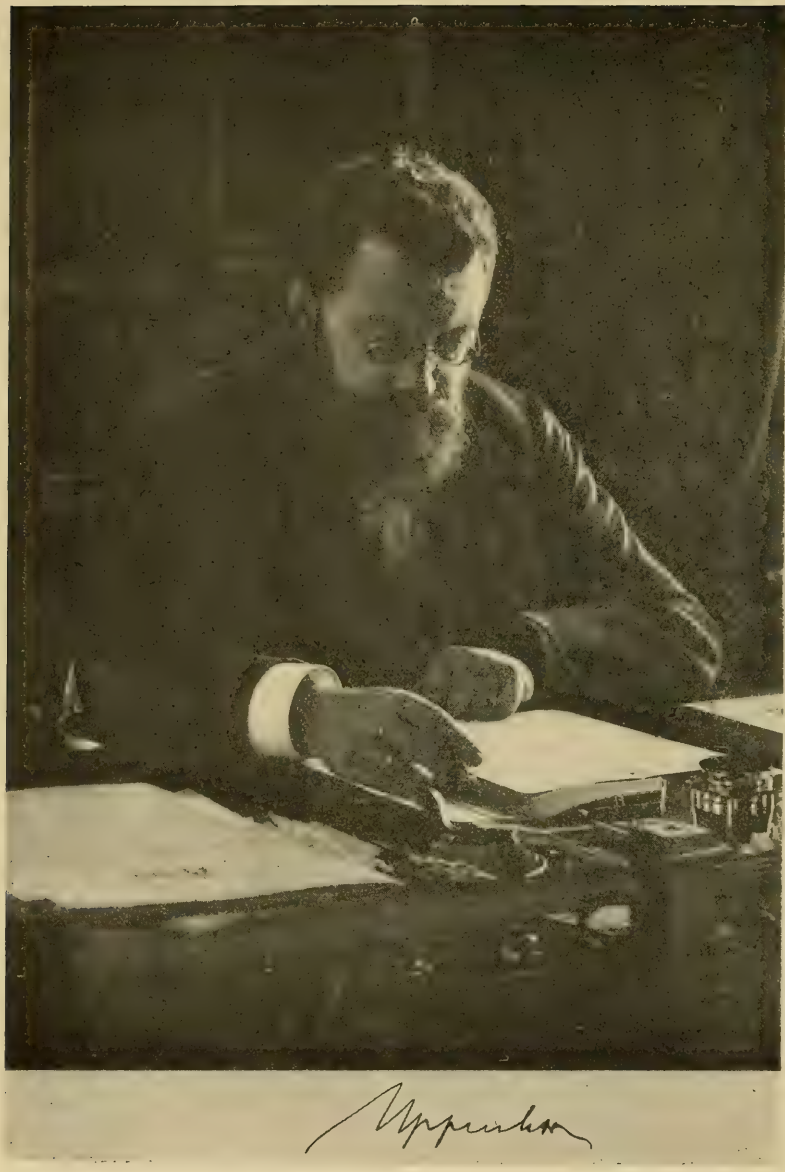

THE LATE FRIEDRICH UPPENBORN.

(See biographical sketch on page 361.)

THE ILLUMINATING ENGINEER

Vol. II. JUNE, 1907 No. 4.

A Year's Progress in Electric Illumination

The annual convention of The National Electric Light Association is the most important event of the year in the field of illuminating engineering. This statement carries no disparagement to gas illumination, but simply expresses a fact, which is so easy of verification as to pass unchallenged by those familiar with the present conditions of the lighting industry. While gas lighting still holds a very important position, and it must continue to do so for years to come, there can be no doubt that electric lighting must hold first place in the consideration of the illuminating engineer. The great diversity of means of producing light electrically, and the consequent necessity for adapting each source to its best use, is largely responsible for the establishment of illuminating enginering as a distinct branch of science. The matter was very well put by Mr. T. C. Martin, in his report as Chairman of the Committee on Progress, submitted at the annual Convention of 1906, in which he says:

"The day of the heterogeneous is upon us; and while the transitional process may be somewhat bewildering, the ultimate benefit to the art when the newcomers shall have determined their permanent value, or absence of it, is obvious. It need not be wondered, therefore, that a new technical body has sprung into existence, The Illuminating Engineering Society, whose work promises to be of the most useful character in bringing the old illuminants up to a higher efficiency, and in assisting to determine the value of the new sources of light. The illuminating engineer has an uphill task, but he has begun to prove that wasted light is wasted money, as well as wasted eyes and health; and that brings his mission home to everybody."

From the purely engineering standpoint the electric light must, on account of its diversity, if for no other reason, come first in work of the illuminating engineer. It is a significant fact that the title of the association which now represents an investment of eight hundred millions in capital, with a payroll of over twenty

million dollars annually, uses the word light as the identifying term. It was as a means of producing artificial illumination that mechanically generated electricity first became a commercial entity. The use of electric current as a means of transmitting power slowly and gradually developed as a side issue of the fundamental object of the central station to furnish electric light; and although this by-product has assumed collectively large proportions, the production of light is still the basic product.

The Washington Convention was the 30th since the founding of the association. The most notable feature of this meeting was the full recognition given to illuminating engineering as a legitimate and distinct branch of applied science.

We are accustomed to think that the past century has been one of extremely rapid progress, and so it has; and yet it has required a lapse of 30 years of time, and the growth of a single branch of the lighting industry to the gigantic proportions represented by nearly a billion dollars investment, to evolve a definite branch of engineering dealing specifically with the use of artificial light. And even at the present time, we have hardly got further than christening the child. Illuminating engineering is still in its infancy, and only years of patient study and practice can bring it to that fulness and accuracy of knowledge which will entitle it to man's estate in the engineering family.

The growth of this new science in the past year has been exceedingly rapid. In all the proceedings of the Convention of 1906, the only mention of illuminating engineering is in the single paragraph of Mr. Martin's report, quoted above. A paper on the aim and importance of illuminating engineering was offered to the proper committee, and refused. In the Convention just held the importance of the subject was recognized to a degree fully commensurate with the general standing of the profession at the present time. The references to illuminating engineering in the various papers and discussions were frequent, and made in such a way as to show that a familiarity with the subject was taken for granted. One paper dealt exclusively with "illuminating engineering as an aid to securing and retaining business." The presentation itself of a paper upon this subject is a record of progress that is especially noteworthy in view of the rejection of a paper on a similar topic by the preceding convention. But more significant still is the fact brought out by the paper, that all the more progressive central stations at the present time not only recognize the legitimacy of illuminating engineering, but have established departments to deal with this branch of the industry.

The full recognition of illuminating engineering as a profession was undoubtedly furthered to a considerable extent by the unusual development in the means of converting electrical energy in the light which has taken place during the past year. Probably there has not been equal progress made in any single year since the electric light became a commercial illuminant. The new methods, which were scarcely more than a dream of theoretical investigators a year ago, are to-day commercial possibilities of proven value. The higher efficiency incandescent lamp has taken its place beyond all doubt or peradventure, and the days of the carbon filament lamp are as certainly numbered. The "one watt lamp," so long dreamed of, is at hand. The question now is not the probability of its commercial success, but the capacity of the manufacturers

to supply the demand. The central station, on the other hand, must adjust financial and commercial conditions to the changes which so great an increase in efficiency must bring about. The situation is most aptly expressed in the memorable words of a former president: "It is a condition, and not a theory, that confronts us."

The carbon arc is likewise doomed. The "flaming," and "luminous," or "metallic arcs," must displace the older form as rapidly as manufacturing conditions will permit. These improvements in the methods of producing light are nothing less than revolutionary. The ultimate results will be less expense to the individual user of light, and an increased revenue to the producers resulting from the wider use of illumination, which is the inevitable result of cheapening any commodity.

The report of a special committee appointed to consider a basis for the sale of light, was another evidence of the general revolution that is taking place in matters of illumination. It records the first serious attempt to measure the value of the light in terms of the illumination produced. While billions of dollars have been paid for public lighting, in not a single instance has the payment been based on any measure of the commodity actually used, namely, illumination. The recommendation of the committee that contracts for public lighting be based upon some measurement of illumination, must be held as one of the greatest steps in an advance that has ever been taken. This progressive step has been made possible largely by the development of instruments for measuring light and illumination which has taken place during the last year; and to go back still further, the development of these instruments has been principally due to the perfection of the metal filament lamp, which has afforded a portable standard of light of a practical form.

The chronicle of the year's progress would be decidedly incomplete without a consideration of the commercial aspects of the case. The commercial progress, which has fully kept pace with the remarkable scientific development, may be summed up in two general statements: First, a systematic and well-directed campaign has been organized and put into execution, aimed primarily at the education of the general public on the use of electricity. Second, an unequivocal stand has been taken in favor of a "square deal" between the consumer and the producer. It was perhaps not fully recognized that this was the natural and necessary conclusion to the campaign of public education. Enlightment, progress, and fair dealing are commercially synonymous terms; and a due appreciation of the numerous benefits to be derived from a wider use of electricity is the sure result of both.

Theory and Technology

Daylight Illumination

By O. H. Basquin.

VIII. Duration of Sunshine

Sunshine is generally estimated not so much in terms of the illumination which it produces as in the number of hours during which the sunshine reaches any particular locality. So far as the writer is aware, there has been no series of measurements made on the illumination produced by sunshine over any considerable length of time. A great deal of work has been done upon the radiation from the sun, particularly on mountain tops. This has been in connection with the study of the effect of the earth's atmosphere upon the radiation of the sun. We are greatly in need of a continued series of experiments upon the illumination derived from the sun at the earth's surface, measured in terms of ordinary units, regard being taken only for that radiation which affects the sense of vision.

The maximum value which the illumination of the sun may reach at the earth's surface has been estimated as something more than 5000 ft. candles.* This varies with the latitude and with the declination of the sun. These values of course give little information as to the actual average illumination at the earth's surface.

Let us confine our attention in that which follows to working out an easy method† of finding the approximate number of hours per year of sunshine possible for any particular window for which the surroundings are prescribed. We shall assume that this window is located in a vertical wall which stands east and west or north and south, that the surroundings which limit the horizon are made up of either vertical or horizontal lines, and that the horizontal lines run either north and south or east and west. This assumption is one which holds true for practically all buildings in American cities, and is the one which we have used heretofore in the study of illumination from the sky.

Figure 1 shows a projected sky diagram of the position of the sun for a window located on a north and south street. This sky diagram should be drawn to the same scale as the sky diagram used for sky illumination (see Illuminating Engineer, Vol. II., No. 1, p. 14, Fig. 2). The sun is said to be on the equator on the 21st of March and on the 24th of September, in as much as its rays fall normal to the earth's surface on those days. During the summer months the sun is north of the equa-

* See article by L. Weber in Weyl's *Handbuch der Hygiene*, vol. 4, p. 69.

† A part of this method was first described by H. B. Molesworth in his *Obstruction to Light*.

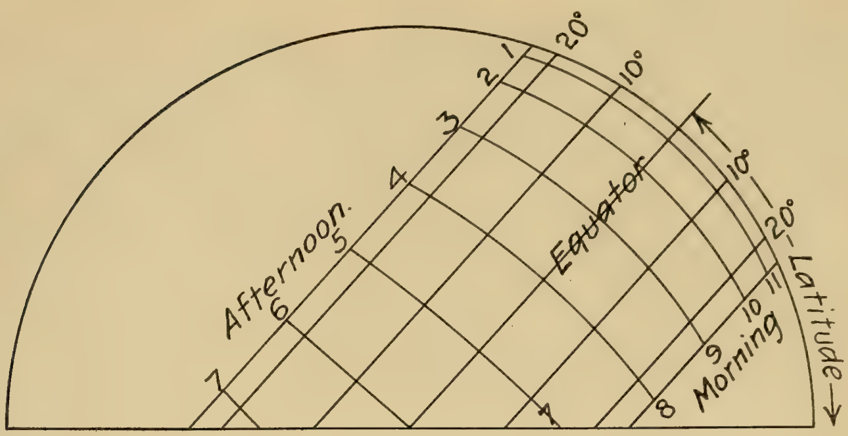

FIG. 1.

tor, and during the winter months it is south of it. In order to locate the position of the sun, we must think of a plane passed through the equator and cutting the sky along an imaginary line. This sky which we now think of as far away may be brought down, in imagination, to a small radius, forming a sphere whose center is at the window. This equator thus marked on the celestial sphere will be a great circle parallel to the actual equator of the earth and inclined to the horizontal by an angle equal to the latitude of the place in question. The plane of this equatorial circle cuts the plane of the window in a line passing through the center of the sphere and indicated in Fig. 1 as the equator.

In the middle of the summer the sun is farthest north. On the 22nd of June its rays fall normal to the earth's surface at a latitude of 23° 27′ north, this being the boundary of the tropic zone. Corresponding to this position of the sun, we have a line on the projected diagram of Fig. 1. This line is a straight line parallel to the equator and at a distance from it equal to the radius of the circle multiplied by sin 23° 27′. In a similar way, on the 16th of April and on the 28th of August the sun is 10° north of the equator and its position will trace a line on the projected diagram, Fig. 1, which is a straight line parallel to the equator and at a distance from it equal to the circle's radius multiplied by sin 10°. This line in Fig. 1 is labeled "10°" at the right. The line labeled 20° has a corresponding meaning, while those lines which are shown at the right of the equator in this figure represent the possible positions of the sun on corresponding declinations south of the equator, viz., in the winter time.

The lines already explained on Fig. 1 are the paths of the sun on these days. At any one time of day the sun is found at some point on its corresponding path. At 12 o'clock noon the sun will be found on the perimeter of this circle, while at 6 o'clock either in the morning or in the afternoon the sun will be found on a line drawn through the center of this circle and at right angles to the equator. This line is labeled "6" in the figure. Between this 6-o'clock line and the circumference of the circle, there must be 5 other hour lines, so located that the spaces between them represent arcs of 15° on the sky globe. Each of these lines is

an arc of an ellipse whose major axis is the diameter of the circle, Fig. 1, and whose semi-minor axis is this radius multiplied by sin 15° or sin 30° or sin 45°, etc. They are shown in the figure labeled "5"—"7," "4"—"8," "3"—"9." etc.

This figure, then, shows the position of the sun in the heavens at any declination north or south of the equator and at any hour of the day. For instance, on April 16th the sun is found along the line marked "10°" and at the left of the equator, and at 4 o'clock in the afternoon it will be represented by the intersection of this line and the line marked "4"—"8;" while at 10 o'clock in the morning its position will be represented by the intersection of this line "10°" and the line marked "2"—"10." It should be noted that if the window in question faces east the only hours of sunshine which are available are those in the forenoon, whereas, if it faces west those available are in the afternoon. The morning hours are given by the numbers below the equator and the afternoon hours are given by those as indicated above the equator.

This diagram is used by placing over it the sky diagram which represents the horizon furnished by the opposite buildings. The method of drawing this diagram was explained in ILLUMINATING ENGINEER, Vol. II., No. 1. In Fig. 2 is shown a map of a street intersection in Chicago, with the angular heights of the building marked thereon, also the angular deviation for a point A on building

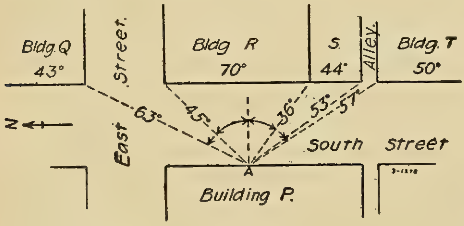

FIG. 2.

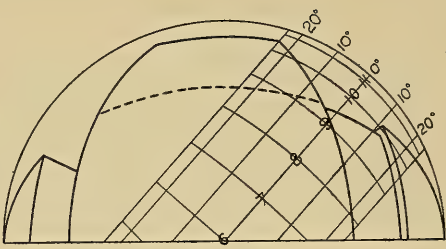

FIG. 3.

P. In Fig. 3 is shown the sky diagram giving the sky line corresponding to this map, Fig. 2. This diagram is seen superposed upon a diagram giving the position of the sun. It is drawn on tracing paper laid over the sky chart as previously explained, and is identically the same diagram as that used in the study of sky illumination. The unobstructed part of the sky is that above the heavy line and below the half circle. The left-hand part of the sky, since the window faces east, represents the northeast sky. The upper part of the sky, of which only a narrow strip remains, on account of the tall building opposite, represents the upper part of the eastern sky, in which the sun never comes. The paths of the sun which are at the left of the sky outline are all obstructed by the opposite buildings, so that the sunshine reaches this window only at the times when the sun is represented by points in the extreme right of the figure, above the outline of the buildings. When the sun is on the equator it is seen that the shadow of the opposite building leaves this window at about 9:25 and the sun continues to shine until noon. When the sun is 10° north of the equator it is possible for it to reach this window from about 9:40 till noon. When the sun is 20° north it first reaches the window at about 10:20, and at the summer solstice, when the sun is farthest north, the shadow recedes from the window at about 10:25.

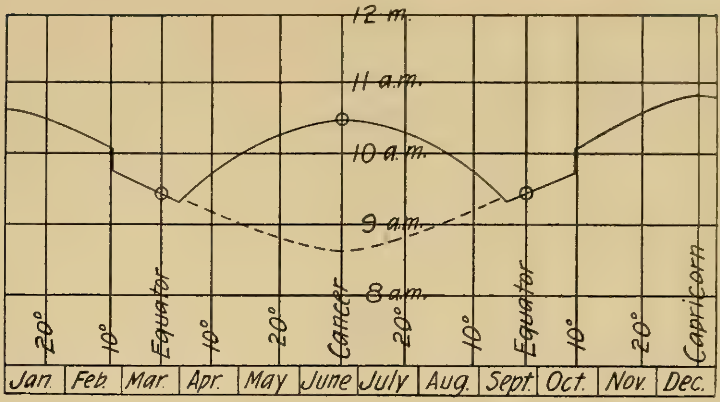

FIG. 4.

When the sun is south of the equator, in the fall, winter, or spring, the shadow leaves the window at various times, ranging from 9:30 to 10:45, as shown by the lower part of this figure, 3. This figure, then, enables one to pick out for different days in the year the number of hours of possible sunshine for this window.

Fig. 4 shows a method of plotting these hours of sunshine so that they may be added together for a whole year. The year is plotted to a horizontal scale at the lower part such that one inch represents a hundred days. The vertical scale represents hours of sunshine for any one day, to the scale of three-eighths of an inch per hour. A square inch of this area, therefore, represents eight-thirds hours of sunshine per hundred days, or 266 hours of sunshine. In using this diagram it might be more convenient to draw it to such a scale that one square inch would represent one hundred hours of sunshine. On the horizontal scale is also shown the declination of the sun by means of the vertical lines—the vertical lines upon which are marked the angles giving the declination of the sun north and south of the equator. This particular diagram is useful only for buildings facing east; but it may be used for windows facing any direction by rearranging the notation on the horizontal hour lines.

In order to draw the curve shown on this figure, one picks out various points by means of Fig. 3. For instance, we have just seen that when the sun is on the equator either in March or in September the shadow leaves the window at about 9:35. These points are then marked on Fig. 4, by the small circles. When the sun is farthest north, the corresponding time we have seen to be 10:25—also marked by a small circle in Fig. 4. In the same way other points are picked out for various declinations of the sun and plotted on Fig. 4. They are then connected by smooth curves, and indicate the times throughout the year at which the shadow crosses the window. It is possible for the sun to reach this window until 12 o'clock, so that the 12-o'clock hour is the other boundary of the sunshine area. The area, now, above this irregular curve and below 12 o'clock represents in the units chosen the number of hours of sunshine possible for this window throughout the year. One may find this area most conveniently by means of a planimeter, although it may be estimated by other methods. For this particular window this area is found

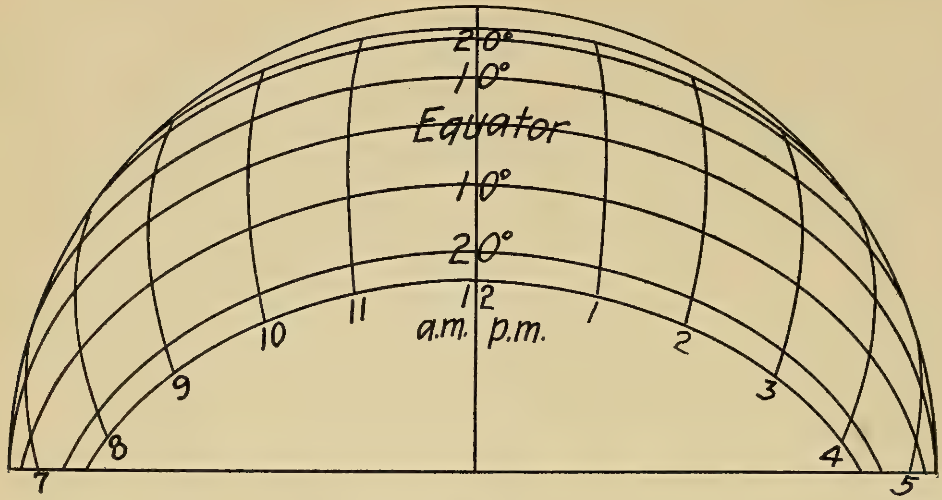

FIG. 5.

to be 700 hours, so that the final result is that there is possible for this window about 700 hours of sunshine per year.

In Fig. 3 a dotted line is seen, which represents the horizon immediately opposite this window before the new building was erected, and in Fig. 4 a dotted line is also seen, which corresponds to this old building top. The oval area between the dotted line and the curved solid line in Fig. 4 represents the decrease in hours per year of possible sunshine for this window on the erection of the new building on this street. This area represents 190 hours per year, so that on the erection of this building the hours of possible sunshine for this window were decreased by about 21 per cent.

If our window faced west instead of facing east, the process of finding the hours per year of possible sunshine would be precisely the same, except that the tracing paper on which the sky diagram is drawn would need to be turned over when it is superposed upon the sun chart. That is to say, left and right on the diagram must be interchanged so that the side of the paper on which the diagram is drawn shall be below. This furnishes no inconvenience. in as much as the tracing cloth is quite transparent.

When the window faces south, two methods of solution are applicable. Fig. 5 shows a projected sun chart for such a window. In this case the line representing the path of the sun when it is on the equator is not a straight line, but an elipse, whose major axis is the diameter of the circle and whose semi-minor axis is the radius of the circle multiplied by the sine of the latitude of the place in question. All of the other paths representing the sun at different declinations are also arcs of elipses. The major axis of any one of these is the diameter of the circle multiplied by the cosine of declination, while its semi-minor axis is equal to its semi-major axis multiplied by the sine of the latitude. With the exception of the equator, the centers of these elipses are not coincident with the center of the circle, but are displaced north and south by an amount equal to the radius of the circle multiplied by the sine of the declination.

The hour-curves shown in Fig. 5 are also elipses. They must be tangent to the half-circle shown there,

and must pass through the point on this diagram which represents the position of the pole both north and south. Fig. 5 is not hard to draw if one has an elipsograph. It must be drawn to the same scale as the sky chart previously referred to. The use of this sun chart is identical with that of Fig. 1.

The other alternative in the case of a building facing south is to draw a projected sky diagram for the window, considering the window turned around into a north and south plane. This can be done in the same way that the ordinary projected sky diagram is drawn, but it alters the meaning of the lines to a considerable extent; that is to say, it makes the meanings correspond exactly to what they would be if the window were turned around as above suggested. After this diagram is drawn it may be used with reference to Fig. 1 in the same way as the ordinary sky diagram.

If the window faces any other direction than one of those above considered, the easiest method of treating it is to project the sky upon the window, considered turned about a vertical axis until it corresponds to a north and south or an east and west plane. Project the sky line upon this imagined position of the window and proceed as above described. The fact that we have considered the window as being vertical does not have any bearing upon the duration of sunshine. It does not matter what the position of the window is, except that the plane of the window itself must generally be considered as one of the limits in determining the time at

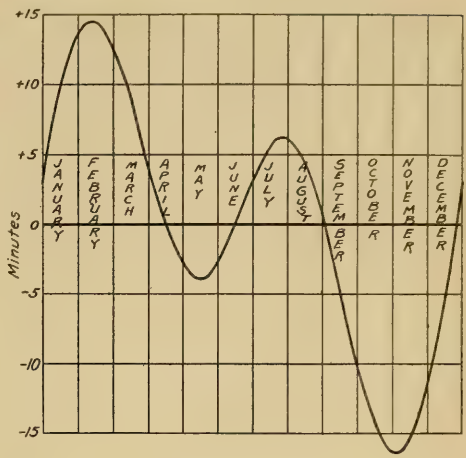

FIG. 6.

which the shadow of the sun will pass across the window, in the same way that we found that the vertical window facing east cannot receive any sunshine in the afternoon.

For Chicago buildings of the average height and facing east or west the average possible sunshine per year for the first floor is about 900 hours, while for a south frontage the average is about 1800.

The hour of day shown on these charts is the hour as indicated by the sun dial, and is not the hour of mean solar time. In Fig. 6 is shown a correction curve which reduces this method of measuring time to the mean solar time. For parts of the year in which this curve is above the axis the number of minutes shown must be added to the sun dial time in order to bring it to the mean solar time, while the reverse is true for parts of the year in which the curve falls below this axis.

Table of Graduations for a Three-Meter Photometer Bar 16 C. P. Standard

COMPILED BY C. L. KNOPF.

C.P. of Test Lamp.	Cm. Distance from Std.	C.P. of Test Lamp.	Cm. Distance from Std.	C.P. of Test Lamp.	Cm. Distance from Std.	C.P. of Test Lamp.	Cm. Distance from Std.
1.0	240.00	.8	1.60	.6	58.93	.4	.77
.1	37.70	.9	1.06	.7	.66	.5	.57
.2	5.53	7.0	180.56	.8	.36	.6	.37
.3	3.46	.1	.07	.9	.05	.7	.17
.4	1.52	.2	79.55	13.0	57.78	.8	43.97
.5	29.66	.3	.05	.1	.50	.9	.76
.6	7.91	.4	78.55	.2	.20	19.0	.56
.7	6.23	.5	.05	.3	56.91	.1	.36
.8	4.62	.6	77.57	.4	.65	.2	.16
.9	3.10	.7	.08	.5	.35	.3	42.96
2.0	1.61	.8	76.63	.6	.08	.4	.77
.1	20.21	.9	.15	.7	55.79	.5	.58
.2	18.81	8.0	75.71	.8	.52	.6	.39
.3	17.48	.1	.25	.9	.25	.7	.19
.4	16.23	.2	74.80	14.0	.01	.8	42.00
.5	15.02	.3	.35	.1	54.74	.9	41.80
.6	13.78	.4	73.92	.2	.48	20.0	.64
.7	12.62	.5	.48	.3	.20	.1	.46
.8	11.50	.6	.07	.4	53.95	.2	.27
.9	10.43	.7	72.65	.5	.68	.3	.08
3.0	9.38	.8	.23	.6	.43	.4	40.89
.1	8.31	.9	71.80	.7	.17	.5	.71
.2	7.30	9.0	.40	.8	52.91	.6	.55
.3	6.30	.1	.01	.9	.66	.7	.37
.4	5.32	.2	70.60	15.0	.41	.8	.20
.5	4.39	.3	.19	.1	.15	.9	.01
.6	3.39	.4	69.81	.2	51.91	21.0	39.81
.7	2.50	.5	.42	.3	.69	.1	.65
.8	1.60	.6	.03	.4	.45	.2	.45
.9	200.80	.7	68.65	.5	.19	.3	.29
4.0	200.00	.8	.26	.6	50.95	.4	.10
.1	199.16	.9	67.88	.7	.71	.5	38.92
.2	8.35	10.0	.52	.8	.47	.6	.75
.3	7.58	.1	.15	.9	.23	.7	.67
.4	6.82	.2	66.80	16.0	50.00	.8	.42
.5	6.04	.3	.44	.1	49.78	.9	.25
.6	5.26	.4	.07	.2	.55	22.0	.09
.7	4.52	.5	65.70	.3	.31	.1	37.91
.8	3.80	.6	.37	.4	.08	.2	.73
.9	3.11	.7	65.00	.5	48.88	.3	.66
5.0	2.43	.8	64.67	.6	.65	.4	.41
.1	1.73	.9	.34	.7	.40	.5	.24
.2	1.05	11.0	.01	.8	.19	.6	.06
.3	190.39	.1	63.65	.9	47.96	.7	36.91
.4	89.73	.2	.33	17.0	.75	.8	.75
.5	89.10	.3	63.00	.1	.52	.9	.68
.6	8.45	.4	62.65	.2	.32	23.0	136.41
.7	7.85	.5	.35	.3	.10	.1	.25
.8	7.25	.6	.03	.4	46.90	.2	.09
.9	6.65	.7	61.70	17.5	146.65	.3	35.95
6.0	6.06	.8	.39	.6	.44	.4	.78
.1	5.46	.9	.07	.7	.21	.5	.63
.2	4.89	12.0	160.76	.8	.01	.6	.48
.3	4.30	.1	.46	.9	45.80	.7	.32
.4	3.78	.2	.15	18.0	.60	.8	.16
6.5	183.19	.3	59.86	.1	.40	.9	35.00
.6	2.66	.4	.55	.2	.10	24.0	34.84
.7	2.11	.5	.25	.3	44.98	.1	.70

C.P. of Test Lamp.	Cm. Distance from Std.	C.P. of Test Lamp.	Cm. Distance from Std.	C.P. of Test Lamp.	Cm. Distance from Std.	C.P. of Test Lamp.	Cm. Distance from Std.
.2	.54	.5	.01	4.0	12.86	1.0	.32
.3	.39	.6	25.90	.5	.46	2.0	91.91
.4	.23	.7	.78	5.0	.06	3.0	.51
.5	.08	.8	.66	.5	11.76	4.0	.12
.6	33.93	.9	.53	6.0	.30	5.0	90.78
.7	.79	31.0	.42	.5	10.90	6.0	.40
.8	.64	.1	.30	7.0	.53	7.0	.04
.9	.49	.2	.17	.5	.15	8.0	89.67
25.0	.34	.3	.06	8.0	9.81	9.0	.31
.1	.18	.4	24.94	.5	.34	90.0	88.98
.2	.02	.5	.84	9.0	.08	1.0	.61
.3	32.89	.6	.72	.5	8.72	2.0	.29
.4	.74	.7	.60	50.0	.37	3.0	87.95
.5	.60	.8	.49	.5	.05	4.0	.62
.6	.45	.9	.38	1.0	7.70	5.0	.29
.7	.30	32.0	.27	1.5	.35	6.0	86.98
.8	.16	.1	.15	2.0	.03	7.0	.68
.9	.01	.2	.04	.5	6.69	8.0	.35
26.0	31.88	.3	23.94	3.0	.35	9.0	.04
.1	.73	.4	.81	.5	.04	100.0	85.70
.2	.69	.5	.71	4.0	5.72	1.0	.42
.3	.45	.6	.60	.5	.41	2.0	.14
.4	.31	.7	.50	5.0	.10	3.0	84.83
.5	.18	.8	.39	.5	4.80	4.0	.53
.6	.08	.9	.28	6.0	.51	5.0	.24
.7	30.90	33.0	.17	.5	.29	6.0	83.95
.8	.76	.1	.06	7.0	3.90	7.0	.76
.9	.61	.2	22.95	57.5	103.60	8.0	.38
27.0	.48	.3	.84	8.0	.31	9.0	.11
.1	.35	.4	.73	.5	.02	110.0	82.82
.2	.20	.5	.62	9.0	2.72	15.0	81.53
.3	.06	.6	.51	.5	.43	20.0	80.24
.4	29.92	.7	.40	60.0	.16	5.0	79.03
.5	.80	.8	.29	.5	1.88	30.0	77.90
.6	.67	.9	.18	1.0	.61	5.0	76.84
.7	.54	34.0	122.07	1.5	.33	40.0	75.79
.8	.41	.1	21.96	2.0	.05	5.0	74.80
.9	.29	.2	.85	2.5	100.80	50.0	73.85
28.0	.15	.3	.75	3.0	.53	5.0	72.95
.1	.02	.4	.65	.5	.26	60.0	.06
.2	28.89	.5	.55	4.0	100.00	5.0	71.21
.3	.76	.6	.45	.5	99.74	70.0	70.37
.4	.64	.7	.35	5.0	.49	5.0	69.61
28.5	128.51	.8	.24	.5	.24	80.0	68.89
.6	.34	.9	.13	6.0	99.00	5.0	.17
.7	.25	35.0	.02	.5	98.75	90.0	67.46
.8	.12	.5	20.52	7.0	.48	5.0	66.80
.9	27.99	6.0	.01	.5	.24	200.0	.12
29.0	.85	.5	19.49	8.0	.02	25.0	63.19
.1	.73	7.0	.01	.5	97.70	50.0	60.60
.2	.60	.5	18.52	9.0	.54	75.0	58.30
.3	.46	8.0	.11	.5	.28	300.0	56.34
.4	.35	.5	17.60	70.0	.03	50.0	52.84
.5	.23	9.0	.13	1.0	96.58	400.0	50.00
.6	.11	.5	16.68	2.0	.12	50.0	47.58
.7	26.98	40.0	.25	3.0	95.69	500.0	45.50
.8	.85	.5	15.78	4.0	.23	600.0	42.10
.9	.73	1.0	.36	5.0	94.79	700.0	39.40
30.0	.60	.5	14.90	6.0	.36	800.0	37.18
.1	.48	2.0	.50	7.0	93.93	900.0	35.30
.2	.35	.5	.07	8.0	.53	1000.0	33.68
.3	.22	3.0	13.66	9.0	.10	1100.0	32.26
.4	.11	.5	.26	80.0	92.73	1200.0	31.05

BY
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Specifications for Street Lighting

The necessity for a more definite, scientific and logical basis upon which to form contracts for street lighting has been recognized ever since the enclosed arc lamp became a commercial light-source. The Colorado Springs litigation showed that the need for such an improvement was acute. The report of the committee appointed by the National Electric Light Association is therefore of special interest, both from the scientific and commercial standpoints. Perhaps no single pronouncement by any authoritative source has ever been more epoch-making in the history of illuminating engineering than the following introductory paragraph of the report:

Your committee, after a most careful consideration of the difficulties to be met and for the purpose of establishing a definite basis, assumed: That, inasmuch as the lighting of streets by contract is a matter of *illumination produced* rather than of *apparatus employed,* the terms used in specifications should be in terms of illumination and not of energy consumed; that the individual lamp of each class should be the unit of number charged for; and that the average illuminating power of each unit should be comparable with and have a value equal to a known standard at proper relative distance.

The recognition thus given to the fact that illumination is the thing which the consumer demands, rather than electric current, apparatus, or even light itself, is of more far-reaching importance than can readily be estimated at the present time. That *illumination* is entirely separate and distinct from *light,* and still more from the ways and means of producing light is the one underlying fact upon which all illuminating engineering is based. When the general public shall have been educated up to the point of appreciating this one fact, the only really serious obstacle in the path of the illuminating engineer, will have been removed.

While the recommendations of the committee are unquestionably a long step in the right direction, and based upon the only logical principle, we can not agree with them *in toto.*

A great deal of discussion has taken place among illuminating engineers as to the proper basis for measuring street illumination, whether on a horizontal, or vertical plane, or on a plane normal to the rays of an indi-

vidual light-source. As the pavement is approximately a horizontal plane, the first thought is usually that horizontal illumination should be the one considered. Against this argument it is pointed out that it is not so much the pavement itself, but objects in the street, such as vehicles and persons, and obstructions, such as stones or even irregularities in the pavement, which are seen by the illumination on the vertical plane. Normal illumination may be taken as a compromise between the two. There is also the positive argument in favor of it, that, when we wish to use the illumination for some special purpose such as reading an address on a card, that the object is always held practically normal to the rays of the nearest light-source. Aside from the effectiveness of the illumination, there is another point worthy of consideration, and that is the facility with which a numerical measurement can be made. Since it is either minimum illumination, or at best, illumination measured at a considerable distance from the source that is required, the intensity will, in all cases, be low, and generally considerably lower than the intensity necessary to reduce the error of visual acuity to its lowest point. The difference between normal and horizontal illumination under the conditions given in the report would be very large, *i. e.,* the horizontal illumination would be very much less. All things considered, therefore, the choice of normal illumination as the basis of measurement has decidedly the preponderance of argument in its favor.

That all illuminations should be measured at the height of the observer's eye, however, is a condition which cannot be so readily accepted. As a chain is no stronger than its weakest link, so, for purposes of traffic, a street illumination is no better than its darkest point. For such unusual and special requirements as reading the address on a card, or the time on the face of a watch, the maximum illumination can always be obtained by choosing a point near the light-source; and in the crudest form of street-illumination the maximum is always sufficient for such purpose at some points. For ordinary purposes, moreover, any maximum far in excess of the purposes mentioned is an extravagance. Generally speaking, you can travel a street no faster than you can safely go in its darkest parts, and the facility and speed with which you can travel such parts is determined by the distance and clearness with which you can see such obstructions as must be avoided. It is as necessary to avoid a hole in the pavement as a passing vehicle, and any lighting which does not provide the ability to distinguish such obstruction, but simply a system of beacon-lighting, serving the same purpose to the traveller as light-houses do to the mariner.

Theoretically, at least, the illumination should be measured as near the pavement as possible. The actual difference in intensity, however, between the pavement, and the height of the observer's eye, would be within the limits of error of the photometric reading, and, therefore, of no practical moment, with the illuminometers now on the market; moreover, it would be very awkward to make the measurement at the height of the eye, and while a measurement at a lower point would give substantially the same reading, it would not fulfill the letter of the law, and might therefore give rise to friction between the two parties to the contract.

The attempt to designate the required illumination by reference to the illumination produced by a 16

candle-power electric lamp, placed at some distance to be determined, as expressed by the fraction 1/X, seems to us most unfortunate. The committee no doubt had in view the supposed difficulty that the layman might have in comprehending the meaning of the term "foot-candle." As a scientific term there are probably very few laymen who have any conception of its meaning; but it is so simple, and so easy of practical demonstration, that it would seem easier to explain the meaning of this standard unit than to beat about the bush in an attempt to avoid the direct issue. It is practically impossible to make a direct comparison of the illumination on the street with that produced by a 16-c.p. lamp held at some specified distance, and the attempt to base a measurement upon a reference to such a unit therefore involves only a needless and meaningless complication. The urgent need of bringing photometric terms to a stable condition is recognized on all sides, and the authority of so important a body as this association would go very far towards establishing the foot-candle as a unit of illumination. If they accomplished nothing more than this, the time of the committee would be well spent.

In regard to measuring the illumination the recommendation of the committee is far from satisfactory.

> For measuring the mean normal illumination of a lamp, comparison with the standard incandescent lamp may be made either with a suitable portable photometer or with a reading distance instrument, such as the so-called "luminometer."

In the first place, it will puzzle even an expert to know how to follow the directions given. What portable photometer is there in existence at the present time which is capable of measuring an illumination down to a hundredth of a foot-candle or less, using a 16 candle power lamp as a standard? Such a measurement would be practically impossible. There are, however, a number of instruments which would give a measurement of the illumination, read directly in foot-candles, which use a miniature lamp as a standard. The alternative of using "a reading distance instrument, such as the so-called luminometer," is only getting out of the photometric fryingpan into the fire. The qualification of "so-called" is well put in. An instrument of the kind referred to should by no means be confused with an illuminometer, or photometer. It is essentially an eye-tester; the readings depending upon the ability of the individual using it to distinguish printed characters under different degrees of illumination. While such an instrument may serve a useful purpose for the professional in making rough qualitative comparisons, it cannot possibly be considered as an instrument of precision, capable of giving quantitative results. Mr. W. D. A. Ryan, who has probably had a larger practical experience with such instruments than anyone else, has publicly expressed himself in agreement with these views.

Stripped of superfluities, the report simply recommends that street lighting contracts should be based upon illumination, measured *on the street*, within specified distances of the light-sources. This is a simple, practical, and logical basis, and one which we have been advocating for the past ten years.

The Relation of Illuminating Engineering to the Electrical Contractor

The business of the electrical contractor is to-day on a parallel with that of the engineering contractor, or

builder. Having its origin in the mere stringing of a few wires for electric bells, it has developed into a department of construction engineering, involving complicated problems, and requiring a high degree of technical knowledge and skill, as well as involving large sums of money. The contractors have a natural organization, the purpose of which is to further the mutual interest of its members, and to introduce uniformity of methods and material, and to generally improve the quality of service and workmanship.

It is true that the larger contracts leave no opportunity for selection or individual judgment, but require only the intelligent performance of well-defined specifications; but the large contracts are not necessarily the largest part of the electrical contractor's business, and doubtless do not furnish the most profitable part. A very considerable proportion of the work deals with smaller installations and repairs; and in this class of work, the contractor is often not only expected to specify what is required, but to give advice as to the best methods to be used. It cannot be denied that confidence in such advice has often been seriously shaken by a mistaken zeal on the part of the contractor to overload the customer with lamps for the sake of the extra wiring. We do not believe that such cases are by any means in the majority, and it is unfortunate that those seeking to do business on a fair basis should suffer for the ignorance of others. Such a short-sighted business policy can only be ascribed to ignorance, for the fact is too well known to require any argument, that only fair dealing can bring permanent and continuous success.

While illuminating engineering has been accepted as an individual profession by those directly concerned with the sale of illuminants and lighting apparatus, the illuminating engineer is still an unknown quantity to the average layman. The consumer who finds his lighting installation overburdensome as to expense, or unsatisfactory as to results, naturally turns to his electrical contractor for information and advice, and there is no gainsaying the fact that if such advice results in an improvement in the customer's condition, either in point of economy or effectiveness, or both, the prestige of the contractor with that particular customer is thereby established so firmly that no amount of persuasion or argument on the part of any competitor can dislodge it. Compared with the gain of a few additional dollars for extra wiring for lights that are not really needed, the value of such confidence is inestimable. When such advice is sought, the contractor who assumes to give it, by the very act of so doing, puts himself in the position of a consulting engineer; and the basis of consulting engineering is absolute impartiality, and freedom from prejudice or financial interest in any particular article or device. The value of the consulting engineer's advice is dependent upon his independence, and his knowledge of the subject.

The electrical contractor doing any considerable amount of business can well afford to employ a special illuminating engineer; and the small contractor can do nothing to strengthen his position so much as to post himself as far as possible upon the subject. As a means of getting business there is no other method that can compare in effectiveness with a practical knowledge of illuminating engineering. It is perfectly safe to say that there is not one installation in five which could not be overhauled by a competent illuminating engineer to the assured profit of the user, both in

money, and quality of results. A practical electrical and illuminating engineer—and there is no reason why the electrical contractor should be both —could with perfect safety contract to remodel installations on a positive guarantee of results as to economy and effectiveness. The amount of business that could be obtained on such a basis should be exceedingly large.

Where the electrical contractor is given full charge, as is in many cases, he is of course responsible for poor lighting and excessive bills, which are chargeable to either his want of knowledge, or wilful misconstruction; and with neither of these faults will the client continue indefinitely to put up.

There is more satisfaction, as well as more money, in being at the head of the procession in any line of business. The leader is always the one who anticipates the wants of the public instead of waiting until they are forced upon him. The public is being rapidly educated in matters of illumination, and with this general education a demand for better methods is sure to follow. There is no time to be lost by the electrical contractor who wishes to be abreast of the time, in posting himself on the engineering side of illumination.

The Etchics of Engineering

A committee was appointed by the American Institute of Electrical Engineers at its annual convention held in June, 1906, to "consider the advisability of preparing a code of engineering ethics, and, if thought best, to prepare such a code," has submitted a report which will be presented at the coming convention. While the proposed code is intended to apply particularly to electrical engineers, the general principles set down are applicable to any branch of the engineering profession, and are therefore worthy of the consideration of illuminating engineers.

Under the head of "General Principles" the following propositions are especially worthy of consideration:

> The electrical engineer should take care that credit for engineering work is attributed to those who as far as his knowledge of the matter goes, are the real authors of such work.

> The electrical engineer should incline toward and not away from standards of all kinds, since standardization is peculiarly essential to the general progress of the profession. This applies to construction, measurement and expression, or nomenclature as well as to conduct, or ethics. Even the tendency to give individuality by providing special construction may sometimes be avoided with advantage.

We have previously called attention to the necessity of working toward standardization in illuminating engineering. There are those who even go so far as to say that the so-called illuminating engineering at the present time is merely the application of individual fads and fancies, dependent upon a particular training, or commercial interests of the engineer." That there is some measure of truth in this assertion cannot be denied, and the sooner this condition can be eliminated the better it will be for the profession. Those disposed to criticize, however, must bear in mind that illuminating engineering is the newest of the applied sciences, and has not the basis of facts which come from experience alone upon which to standardize, as in the case of the older branches of engineering. The most crying need of the profession at present time is the publication of data acquired by those actively engaged in practice, especially with reference to the results obtained. It is only by the accumulation of a considerable mass of such information that the intelli-

gent choice of methods requisite to standardization of practice can be accomplished.

Under "Relations of the Electrical Engineer to His Employer, Customer, or Client" the following particularly applies to the conditions that have been criticized:

Electrical engineers in a position to decide on the use of inventions, apparatus, etc., should not be financially interested in their use, as by receiving a royalty, etc., unless the matter is clearly understood by the client.

The practice of commercial companies of supplying "free" illuminating engineering advice would fall distinctly under the bann of this article of the code. An offer to "give away free" a five-cent dish with a pound of baking powder may impress those whom it is intended to reach as being sincere; but anyone having the slightest commercial experience or knowledge would at once understand that the baking powder was a cheap adulteration, and the dish actually sold for two or three times its value. What, then, must be the opinion of one thoroughly conversant with legitimate business-principles, of an engineering service offered "free" by a corporation or individual engaged in the manufacture or sale of illuminating devices? Such offers will naturally be considered in the same light as the medical profession consider patent medicines, namely, as "unethical."

The "relations of the electrical engineer to the general public" will apply literally if the word "illuminating" is substituted for the word "electrical":

The electrical engineer should endeavor to assist the public to a fair and correct general understanding of engineering matters, spread the general knowledge of electrical engineering, and discourage wrong or exaggerated statements on engineering subjects published in the press or otherwise, especially if these statements are made for the purpose of, or may lead to inducing the public to participate in unworthy schemes.

Controversies on engineering questions, however, should never be carried on in the public press, but should be confined to the technical press and the engineering societies.

First publication of inventions or other engineering advances should not be made through the public press, but rather through the technical press and the engineering societies.

The publications which an electrical engineer is justified in making through the public press should therefore be of a historical, educational, instructive or similar character and should not relate to controversies between engineers or on engineering questions, to new inventions, etc., nor contain technical criticism of fellow engineers, and it should be considered unprofessional to give opinions without being fully informed on all the facts relating to the question, and on the purpose for which the opinion is asked, with a full statement of the conditions under which the opinion applies.

In giving expert testimony before judicial bodies, the electrical engineer should confine himself to brief and clear statements on engineering or historical facts. He should not give personal opinions without so expressly stating, and should avoid pleading on one side or the other.

The "relations of the electrical engineer to the engineering fraternity" are likewise applicable to illuminating engineers:

The electrical engineer should take interest in and show due regard for the electrical engineering societies and the technical press.

He should assist his fellow engineers by exchange of general information, experience, instruction, etc.

He should not take a position left by another electrical engineer without satisfying himself that the former has left it voluntarily, or for proper reasons.

Where engineering work is in charge of an electrical engineer, no other electrical engineer should undertake the work except on request of or in co-operation with the electrical engineer who had charge of the work before, unless the latter's connection with it has already terminated.

An electrical engineer in responsible charge of work should not permit other engineers or non-technical persons to over-

rule his electrical engineering decisions. If this is done and persisted in, he should as soon as is practicable withdraw.

In engineering work in charge of a board of engineers, the respective limitations of the authority of each should be decided at the outset, and each electrical engineer should give full and complete information on his part to the other engineers and insist on this being reciprocated.

We particularly call attention to the paragraph next to the last. The problem of the "butting-in" of others, both professionals and laymen, into the work of the illumining engineer is not always an easy one to solve, and, until the profession has more firmly established its right to existence, will require no small amount of tact, discretion, and bulldog-tenacity. The most serious interference is likely to come from the architect, who, besides being a jealous god, commonly labors under the hallucination that he is an artist, and that all engineers are, of necessity, a menace to his 'art." The electrical engineer, fixture-manufacturer, or decorator may also have to be reckoned with. It may very well happen that the illuminating engineer may have to fight single-handed the whole combination, in which case the directions of the Englishman to his son who was about to go away to school may be metaphorically followed: "Don't fight; but if you do fight, go in with your fists doubled up."

The Illuminating Engineering Society Convention

The official announcement of the First Annual Convention of the Illuminating Engineering Society will be found in another section in this issue. The place is Boston, and the time the 30th and 31st of July. This time was chosen in order that the general festivities incident to "Old Home Week" might be added to the more sedate enjoyment which the regular program of the society is expected to furnish.

Let no one be deceived in supposing that New Englanders in general, and Bostonians in particular, are an inhospitable people. From personal experience we know that this tradition, which has gained some ground in the West, is as baseless in fact as the story of William Tell, or the adventures of Rip Van Winkle. Reserved they may be, but inhospitable, never.

As an objective point for a summer excursion no city on the Western Continent can surpass Boston. Rich in historic interest, quaint and beautiful in its peculiarities, surrounded by the most charming variety scenery, and accessible to mountain, ocean, and river, it offers attractions for the summer tourists that cannot be surpassed. When we add to these natural attractions the special gayeties which are being provided for the most glorious event of the whole year in the eyes of Bostonians, and still further, the opportunity of attending what, in future years, will be looked upon as a classic event in the history of illuminating engineering, the combination will surely induce every member of the Society to forsake every other vacation plan, if necessary, and cleave only to this particular event.

An excellent program of papers on representative subjects, by authorities particularly qualified to treat of the matter in hand, will be provided by the Committee on Papers; and various social events will also be arranged. We would especially urge upon those attending to bring their families. Illumination is not exclusively a subject for the consideration of mere man; generally speaking, women are more interested in actual results than are men; and as users of light, therefore, their interests and opinions are as much to be sought as any mere mathematical or technical knowledge.

Commercial Engineering of Illumination

The Commercial or New Business Day at the Washington Convention

The commercial engineering of illumination had its inning on the last day of the Convention and scored in a matter to rejoice the hearts of the whole electric lighting fraternity. A most excellent and comprehensive programme of papers had been arranged, and although the previous days had been enthusiastically given over to carrying out the strenuous business and social programmes provided, the full attendance and lively interest manifested showed that the participating members intended to miss nothing of the "feast of reason and flow of soul" that had been so generously provided.

The commercial programme was headed by the report of a committee appointed at the last Convention to assist in the further development and prosecution of the plans of the Coöperative Electric Development Association. This committee consisted of W. W. Freeman, Chairman, John D. Gilchrist, R. S. Hale, J. E. Montague and F. M. Tait.

The following paragraphs of this report are particularly pertinent:

The members of your committee believe that through the wise expenditure of the money which would be available to the association through such joint participation, results along the lines of commercial development would be achieved which would repay many times the expenditure, and in which every subscriber would receive his full share of benefit.

Of course, the movement, to be effective, would be so conducted that companies withholding their support would be likely to enjoy the benefits of the movement equally with those who would bear the cost; but a general movement of such character, if inaugurated and supported at first by the broad-minded and more progressive manufacturing and illuminating companies, would within reasonable time command the financial support of practically all.

In general, this movement would constitute a clearing-house for ideas and methods and an effective publicity bureau for the popularization of the use of electricity for all pracitcal purposes. Through its organization and the wide scope of its work it would accomplish results, the country over, which could not be brought about through other than an extensive co-operative movement.

Following this report Mr. Henry L. Doherty presented his views on "The Possibilities of Commercial Development." When Mr. Doherty speaks, those interested in any branch of the subject will do well to sit up and take notice. If there is a more broad-minded and progressive management than that given to the various companies in which he is interested, we have yet to discover it. It is an old saying that "example is better than precept," but both together are better still, and this is the combination afforded in Mr. Doherty's remarks.

On the subject of light in particular, Mr. Doherty said:

When the men who exploited our large national expositions wanted to make the whole world wonder and the tongues of the whole world wag, they did not depend upon the area of their exposition grounds nor the magnitude of their buildings, but depended almost entirely on the lavish use of light. Light is synonymous for optimism. Artificial light attracts everything animate, from bugs to men. The most famous feature of New York City to-day is the lavish lighting of upper Broadway.

The thousands of visitors who have been attracted to the national expositions by the lavish use of light can be attracted to any city that uses light with equal profusion. For every dollar of benefit secured by the national expositions ten dollars of benefit will be secured to the city that can make its lighting brilliant to a degree that will attract universal attention and wonder.

In another public address, made some years ago, I predicted that the progressive merchant in the future would display as lavish lighting as was then characteristic of the national industrial expositions. This, I think, has proved nearly true, and I think it is safe to say that no one has yet reached the point where further lavishness in lighting will not pay.

The lavish displays already made have proved profitable, and as each merchant has endeavored to excel the other the additional lighting has been relatively even more profitable.

We used to talk about the point of saturation, meaning that time when we should have sold all the light and power that could be sold in a given city. If there is such a thing as the saturation limit we have not yet found it. I can say truthfully that the longer we carry on the development of work, the more easily additional business is acquired and the more business there is still in sight. We are now taking on business in some of the stations with which I am connected at a greater ratio each year than the entire business of any central station amounted to when I first became interested in the subject of development of the market.

"New Business: How to Get it—How to Keep it," was the subject of a paper by Mr. Frank M. Tait. Among the methods to be pursued the following are specially worthy of attention:

Every central station should provide a library containing a number of the best books on the various branches of the business, and also have on file the various electrical magazines and papers, to enable the young men in the various working departments of the company to qualify themselves theoretically as well as practically for the position of an expert on the new business force. The solicitors can also make good use of this library and, as a result, will become better new-business solicitors. The most aggressive central stations in the country to-day complain of the difficulty of procuring men who can continually bring in the profitable new business required. The salary commanded is high and the training excellent, with a wide field always before the expert solicitor.

To fortify the solicitor in his daily rounds for new business, it is essential that the company do all in its power to have all complaints—real or fancied—reported by consumers or observed by the company's employees, corrected promptly and satisfactorily. Good service and courteous treatment should always be the watchword, and reasonable rates for the various kinds of service should be the rule. Do not leave anything undone that you can do to enable the company to retain the good-will and confidence of the general public. You must have this confidence to obtain and keep the maximum business.

No opportunity should be lost sight of to keep the progressiveness of the central station before the public, for the live community likes to feel that its business interests are wide-awake, and the dormant locality should be aroused by the aggressive lighting company whose name should always stand for progress. * * * It is this constant pounding of ELECTRICITY into the minds of the public that sooner or later has its reward in more new business.

Every progressive lighting company should have a display room of some kind, and it should be kept in first-class and attractive shape. * * * The correct type of display room, brilliantly lighted outside as well as inside, will be an attractive point for people in all walks of life, drawn by the unusual brilliancy which should be its chief feature at night, and the new-business solicitors will find the display department a very potent factor for them to bring prospects for the final arguments, demonstrations and closing of contracts.

That such principles are not mere theories and platitudes is shown by the almost startling results actually obtained by small central stations. Thus:

In a town of 10,000 inhabitants, in the far West, a company decided about a year ago to take up the aggressive new-business scheme, and it reports that for the first two weeks in April of this year it has secured the following new business:

Wired one hundred old houses.

Twenty-five lamp signs sold and installed.

Two hundred and fifty flat-irons sold.

Eight coffee percolators installed.

One hundred and twenty horse-power in motors installed.

It estimates that this new business will return an annual gross revenue of $10,000 and that $1,200 was spent to secure it.

Another example is found in an Ohio village with a population of 1,400. This company states that its capitalization is $15,000, all paid in, and no bonds. All of the additional investment has been made out of the earnings, besides which it has paid 33 per cent. in dividends in seven years.

A short paragraph, but one which should not escape attention is as follows:

It has been found that the new business department of any company, properly exploited, is a very great factor in popularizing the company.

As to keeping business that has already been obtained Mr. Tait had the following very simple formula, which, if conscientiously followed would completely satisfy all demands:

After the business has been obtained, keep everlastingly after the consumers and be sure their service is satisfactory and that they are getting what they were promised, and a little more, and hold out to them further and larger uses of the current.

This excellent paper closes with the following appeal based upon irresistible facts:

Those companies that have not yet installed new-business departments or taken up the matter aggressively, those that have taken it up in a half-hearted, dreary manner, those that have a pet theory that their respective methods of obtaining new business are the best, should keep before their mind's eye the excellent results obtained by the little village in Ohio of 1,400 people where progressive new-business-getting of the most pronounced type has produced a revenue of $8.50 *per capita* and still increasing, and this in the face of competition from a good supply of natural gas in the village, at 25 cents per one thousand cubic feet. Any central station man who has made it a point to learn the *per capita* yearly income that is obtained to-day by the various large companies, as well as by many average and small companies, will thoroughly appreciate what $8.50 *per capita* means.

Think of it—small companies, medium companies, large companies—$8.50 per year for every man, woman and child, and then let us go home from this convention and decide that we will all take a new hold on the commercial end of the various companies and strive to emulate our small contemporary who accomplished these wonderful results by simply keeping after it! Let us go after the new business energetically, and when we obtain it, carefully husband it and enlarge it, and use every possible addition to our gross receipts as a stepping-stone for more and better results.

"New Business Results, Demonstrated in Cities of all Sizes," was set forth by Mr. J. E. Montague. The paper was particularly valuable as showing the actual results of various methods of seeking new business. Mr. Montague gives his general conclusions at the outset. To justify these conclusions statistics were given from towns varying in population from 1,350 to 1,425,000.

The results of the commercial departments of many central stations indicate the following interesting facts:

First—That the *per capita* incomes in such stations rapidly pass the average of those where live active interest is not taken in the commercial development.

Second—That expenditures of from 3 to 5 per cent., and even more, of gross income on business extension along proper lines is fully justified by the results. This percentage of expenditures, it will be noted, is very small as contrasted with more competitive lines of business.

Third—That the load curve is very materially improved, and in consequence the ratio of gross income to operating expense.

Fourth—That central stations which have operated these commercial departments for two or three years, or even longer, do not, as at first might be expected, reach the point of business saturation, but continue to maintain the rate of increase through educating the public to higher standards of service and through the introduction of new devices and appliances.

Fifth—That aggressive commercial departments are the most important factors in the cultivation of improved relations with the public and have in numerous instances been worth to companies all they cost from this standpoint alone. We should soon reach—if, indeed, we have not already reached—the point where the commercial engineer in his work of creating and extending the business will be entitled to take equal rank and importance with the electrical and mechanical engineer in the perfection of his work of producing, generating and distributing apparatus and the reduction of current cost. It would seem that the mechanical and electrical engineer should welcome the advent of the commercial engineer, since the efforts of the latter are directed to extending the field of operation of the former and toward introducing more largely the comforts, conveniences and benefits of the entire art.

"Sales Policy of a Combination Gas and Electric Company," is the title of a paper by Mr. F. A. Williard. The following extracts represent the basic ideas set forth:

First, in order to insure the successful operation of any company there must be a well-defined policy, or system, governing the corporation as a whole, likewise each department must have its individual policy and system, and all departments with their systems must work together smoothly as an intricate, well-oiled piece of machinery.

Mapping out the policy of gas and electric corporation is, I am aware, a stupendous subject in itself, and one in which I shall not attempt to go into detail, but there is one phase of it that is pertinent to the subject we are discussing, and that is the attitude the company assumes toward the public. The good will and friendship of the public is essential to the success of any gas and electric corporation; therefore the local situation should be carefully studied and any obstacles that stand in the way of obtaining the favor of the people should be removed, or overcome so far as possible and consistent with the rights of the company.

Policy.—Give the consumer the most for his money. Carefully consider his interests, and in all cases install the service that will give him the most satisfactory results, economy and practicability considered. Take the time and trouble to demonstrate to him, by figures so far as possible, the advantages of the installation you recommend. This policy will in most cases produce the following results: All short-hour business will go to gas; all long-hour business to electricity. By following this plan you will not only succeed in giving the consumer the most satisfactory service, but will also operate your gas and electric stations under the most economical conditions.

Selling Appliances—Electric.—It is my opinion that the managers of gas and electric companies are becoming convinced that in order to get the best results appliances should be sold and installed by the company. In this way the company is able to regulate the selling price, keeping before the public the appliances best adapted to its needs, and at the same time protecting the consumer against possible unfair treatment at the hands of local contractors.

Electrical Contractors.—In every town of 25,000 inhabitants or over there are electrical contractors whose business it is to sell and install electrical appliances, from the sale of which they expect to make a living profit, and as this class of people are good agents for the electrical corporation, I believe it is wise to protect them in so far as it is consistent with the policy and operation of the company. In order to do this the selling price of appliances should be fixed by the company, so far as possible, at what would be considered a fair profit to the electrical contractor.

Wiring Department. — The company should also maintain a wiring department, which so far as possible should be operated so as to produce the same margin of profit as appliances. This policy, if followed out carefully, will interfere very little with the business of electrical contractors.

Gas Appliances.—On gas-consuming appliances we find a different situation. The method of handling and pushing the sale of gas-consuming appliances depends to a great extent upon existing conditions. In a town where the residences and existing factories have not been educated to the use of gas the company must first create a demand for gas through the medium of the papers, the plumbers, contractors, and its own representatives and solicitors. The

contractors and plumbers should be educated to understand that the company is *creating a demand for gas,* incidental to which they are getting a large percentage of piping work, which they otherwise would not be able to obtain.

Lighting.—The question of lighting by combination gas and electric companies has, I think, been solved by most companies along the lines mentioned—that is, as far as possible, all long-hour business to electric lighting; all short-hour business to gas.

Special Lighting—Residence.—In the better class of residences in any town or city I would recommend soliciting both gas and electric lighting. You will find that people of this class favor the use of gas for fuel and special appliances. They will also use combination fixtures throughout the residences. By so doing you will get a larger revenue from each than you would if you allowed but one service in a house.

Lamp Improvements.—The possibility of turning more long-hour business over to the electric end has been made easier by recent improvements in electric incandescent lamps. With a tungsten lamp of 50 candle-power (consuming 62.5 watts per hour, at the rate of 10 cents per kilowatt-hour), the cost of operation will be 6.25 mills per hour, while the ordinary Welsbach gas lamp, using 4 feet of gas per hour and producing 48 candle-power (with gas at $1.00 per thousand feet), would cost 4 mills per hour. This shows an excess cost over gas for operating the electric lamp of 2.25 mills per hour, and it is the first time in the history of the business that electric lighting has been anywhere near on an equal footing with gas.

Complaints.—There is sometimes an inclination among subordinates of any gas and electric company to make the assertion that certain consumers who make complaints are kickers. Sometimes this is partially excusable, but this conditon is absolutely wrong and every effort should be exerted to educate subordinates not to take this stand, no matter what the nature of the complaint may be. The consumer in making the complaint is virtually asking you to sell him your product, and you should be more than willing to make any reasonable adjustments necessary to that end. After a complaint has been adjusted a letter should be written to the consumer, stating what you have done and asking him if the work has been completed to his satisfaction. The object in doing this is to get consumer to write you a letter stating that his service is satisfactory in every detail. After he has once put this in writing you will find he will hesitate before making the statement to his friends that the company is giving poor service or is inattentive to the complaints of its consumers.

Gratuitous Work.—The following is an excerpt from a recent issue of the *Looker-On:*

"The friendship of its community is the most valuable asset a public corporation can have. The company can win it only by deserving it, and letting the community know that it does deserve it."

This is strictly true in every sense of the word and should be lived up to conscientiously. In addition to carefully looking after your consumers' complaints, there is a large amount of work which a gas and electric company must perform free of charge in order to insure good and satisfactory service; for example, cleaning out service, testing pipes, capping an opening, equipping all burners in a house with new and up-to-date burners, inspecting plumbing during the course of construction of house, testing wire, repairing sockets, changing lamps, and so forth.

"Coöperation of the Electrical Trade Papers in Business Getting," was reviewed by Mr. F. W. Loomis. After giving an appreciative résumé of the work done by the technical and trade press in promoting the commercial field, Mr. Loomis makes the following appeal, to which we give a most hearty Amen:

The technical press has given us much in the past. It hopes and plans to give us more this coming year, but, to do this, it requests our aid and assistance. By helping it we help ourselves. A suggestion, a few words, a hint here and there, a plan or a photograph to the papers, and the thing is done.

Let each one show his appreciation of the success of the trade papers for the past year, and enthusiastically work to co-operate with them for this, the coming year. We must give a bit, not take all the while, and a successful year will result.

We cannot leave Mr. Loomis' paper without quoting the following paragraph, which is an especially gratifying recognition of the efforts

which we have put forth during the past year to establish the profession of Illuminating Engineering:

There is one of the technical papers that is, in a way, different from all others; that is the Illuminating Engineer. It covers what is comparatively a new field, and during this, its first year, has been most successful, as well as a distinct help to the progressive lighting salesman. It has thrown light upon subjects that the average central-station man has known but little of in the past. During the coming year this magazine plans to broaden out and devote more space to the commercial side of illuminating engineering. Papers on the subject will be written by practical lighting engineers, and the central station lighting men should co-operate in any way they can to aid in the work.

"How to Get the Old Buildings Wired" was the question which Mr. F. H. Golding answered, in a brief but excellent paper. After outlining the general method of systematizing the work, Mr. Golding gives the following advice:

If the solicitor is at first unsuccessful in interesting the prospective subscriber to the extent of lighting his entire premises with electricity, he should endeavor to secure an entering wedge in the shape of a cellar or porch light, an electric iron, sewing-machine motor, or any other appliance that he thinks will most appeal to his prospect, offering the free use of same for a 30 or 60-day trial, provided the prospective customer will pay for the small amount of wiring necessary and for the current consumed.

It is right here that a liberal policy on the part of the company is of vital assistance to the solicitor, as the appliance most favored may be a heating pad, night light, or something else in which the current consumption is negligible. Having obtained a foothold, it is comparatively easy for a capable solicitor to gradually extend the uses of electricity in a home by a diplomatic and unobtrusive introduction of other appliances, so that almost before the householder realizes it he is relying on electricity for his light and various other needs and wondering how he could have gone without it so long. The enthusiastic testimonial of the pleased subscriber thus obtained is of material assistance to the solicitor in his work in neighboring houses, hence the importance of obtaining at least one on each block.

The company should be prepared, where conditions seem to warrant and the prospective customer's responsibility is assured, to offer a proposition whereby the installation of wires and fixtures may be paid for in instalments—weekly, monthly, or quarterly, as may be desirable. By this means many customers can be secured who would not otherwise feel able to meet the installation expense. If the central station does not do interior work, a satisfactory arrangement could be made with the electrical contractors whereby the latter would add, say, 10 per cent. for interest and the expense of carrying the account, the lighting company guaranteeing the contractor against loss. As the cost of the average installation will not exceed $100, the percentage added will lay no great burden on the customer.

"How to Get New Buildings Wired" was the subject treated by Mr. J. Sheldon Cartwright. The practically universal application of electricity to the needs of modern life are pithily set forth in one of the opening paragraphs as follows:

It seems almost a sacrifice of our time and energy to question for a moment that in any community with modern ideas and practices on this hustling globe of ours, with the seemingly inexhaustible developments that are being made in electrical science and appliances, that there could exist a man, body of men, company or corporation that would erect any kind of a building for any purpose whatsoever, except a dungeon or perhaps a gasometer, unless it were wired for the use of electricity and the various appurtenances connected therewith.

In the wiring of new buildings the representative of the electrical interests runs afoul of that reef upon which the electrical contractor in general, and the illuminating engineer in particular, is so often hopelessly wrecked, namely, the architect. It is one of the unsolved mysteries of modern building, that while expense will be incurred without stint for all other forms of useful or decorative features in a building, when it comes to the

lighting, the installation is subjected to the most pinched and parsimonious methods, with the result that the illumination is commonly inadequate and inefficient, and out of all keeping with the general character of the building. For the anomalies of illumination which are so generally in evidence, the architect is almost wholely responsible. The confidence which the average builder reposes in his architect is almost sublime, a result possibly of the general air of omniscience which the architect wears as a halo upon his head. It will be a great day for the illuminating engineer when this divinity that doth hedge an architect is at last penetrated by the fact that there may be some special departments of human knowledge which he has not entirely compassed. On this topic Mr. Cartwright makes the following apt comments:

As a general rule the majority of building syndicates, as well as individual owners, place implicit confidence in some one firm of architects and give careful consideration to any recommendations that the architect may make to them. Outside of the pecuniary gain that results to both the architect and builder on account of the increased cost, the architect occupies the same relative position to the owner as a lawyer does to his client. To the architect, then, your central-station solicitor should turn and continue his endeavors and make his arguments as to the advantages of having the proposed building wired. He should offer to assist in the layout of the lights, outlets and so forth, so that the most advantageous conditions can be realized; he should supply the architect with all necessary data and literature of the various electrical appliances, labor-saving, heating and cooking signs, motors and general illuminating in its various forms —in fact, everything up to date that he can conceive of or suggest—and should keep up a persistent, but not obnoxious, hammering until he has gained his point. If possible he should arrange a meeting with the architect and owner together; and there is one thing that he should always remember, and that is, that those to whom he is talking and whom trying to convince are not supposedly technical on electrical matters.

Mr. Jas. R. Strong, of the National Electrical Contractors' Association, made a convincing appeal for coöperation between the central station and the electrical contractor, and for the more complete standardization of the methods, materials and appliances entering into wiring installations. On the subject of coöperation Mr. Strong spoke of the work already accomplished as follows:

The contractor and his organization have been co-operating for a long time along the lines of standardization in several ways:

With the Underwriters for the improvement and simplification of the *National Code* and its uniform interpretation.

With the manufacturers for the standardization of sizes of various fittings and appliances.

With various legislatures for the standardization of work by licensing and bonding the contractor.

With the architects for the introduction of uniform symbols for wiring plans.

As to coöperation between the contractor and central station he doubtless voices the unanimous sentiment of his association in the following:

Can the jobber and contractor look with favor on a proposition to boom the business of the lighting company which, for the purpose of extending its business, sells thousands of fans to the public at manufacturers' prices? Can the jobber and contractor be expected to grow enthusiastic over the idea of contributing to increase the business of the lighting company which purchases its supplies from the manufacturer and employs a hundred or more men in wiring buildings for cost or less? The answer must be "No," unless the electrical trade has reached a more advanced stage of philanthropy than I think it has.

Mr. George Williams treated briefly but comprehensively the question of "Sizing up the Territory and Preparing the Lists of Prospective Customers" for the solicitor.

The qualifications of solicitors or different classes of business was treated by Mr. Frank W. Frueauff. His idea is that

The solicitors or representatives em-

ployed by electric light and power companies should develop into specialists as the importance of their particular work and the distinction between different classes of business become more apparent.

He then divides the solicitor's field into several divisions and has the following excellent suggestions on matters pertaining especially to illumination:

Sign and Display Work.—The representative best fitted for this class of work is the one who can set forth intelligently the value of electric advertising and publicity. He must be able to present his proposition as one of increasing the revenue of the merchant by an advertising expenditure. His ideas must be along those of the latest advertising methods—always keeping in mind that a display made for one merchant in a given line of business is impossible for another, and therefore he must be both original and versatile. He should possess the optimism and enthusiasm of the usual solicitor for advertising.

He should know how to figure the cost of building a sign, its cost of erection and painting. He should keep closely in touch with current literature or work being done in other cities in order that he may be able to present new methods of display. A great deal of business can be secured from merchants in the same line of business if a variety of suggestions can be given.

The representative should make a study of the relative value of various classes of advertising, and be able to show the consumer that the cost per opportunity for electric advertising is much less than any other known method.

Window Lighting.—Many of the qualifications for sign and display lighting work apply here; but, in addition to those, the representative should make a study of the best classes of window dressing and have a good knowledge of decorative lighting and illuminating engineering. The solicitor should study the catalogues of all the supply houses and fixture houses, keeping in mind any new methods of reflecting or diffusing light. Variety in methods of window lighting is as desirable as it is in sign and display lighting. Many windows where a great deal of lighting is found appear badly lighted simply through a poor arrangement. The representative should study particularly along these lines.

Interior Lighting.—A solicitor working on interior lighting is best qualified if he has a complete knowledge of illuminating engineering, thus knowing how to secure the best effects with the least outlay to the consumer. A solicitor without this training can accomplish little permanent result.

The solicitor should be thoroughly posted on the rates charged by his company for service under various conditions. There are many desirable opportunities for interior lighting that can be taken on by a change in the rate where the load-factor is improved.

He should have a very positive idea of the value of electricity as compared with any of the other illuminants. The activity of competing gas companies can only be overcome by an intimate knowledge of the various ways in which electricity can be applied more satisfactorily. He should make a study of all the new forms of lighting as they come out, and aim to interest his prospects in anything novel, thus gradually increasing the standard of illumination.

"How to Measure Results and Pay Solicitors" was answered by Mr. Leon H. Schereck. A most satisfactory basis for compensating the solicitor, as Mr. Schereck sees it, is as follows:

I believe that solicitors for electric-lighting and power companies should be paid a fair salary, sufficient at least to cover living expenses, and in addition to this a commission to be based upon the net returns of the business that they have brought in; but I would allow a commission only on new business that remained on the company's books for a certain length of time, say at least six months, and would base this commission upon two things: First—The revenue for the new business for six months (referring to the new business brought in by the solicitor) in excess of a certain amount. Second—The revenue for this new business for six months in excess of a certain amount per kilowatt demand. The commission thus determined should be allowed but once, and only to those solicitors who are with the company at the time the commission is compiled. Just what the percentage commission should be and what the fixed amount in excess of which the commission should be allowed, will have to be worked out by each company, and even varied for different districts of the same city, as of course

a larger percentage commission and a less fixed amount should be allowed in those districts in which business is hard to secure.

I believe, too, that the amount of commission to be allowed should be limited so as not in any case to exceed the salary of the solicitor, in order to protect the company against excess payment to solicitors due to any unusually large business which, while credited to the solicitor, might not in reality be due to his efforts. In addition to the commission on new business I would recommend that at the end of every six months or a year a certain bonus be allowed the solicitor on all old business retained on the company's books through his individual efforts. This in order that time spent in holding old business—perhaps more important than securing new—should not go unrewarded.

"The Value and Use of the Solicitor's Handbook" was discussed by Mr. R. S. Hale. The points which Mr. Hale makes are as follows:

The *Agents' Handbook* as used by the Boston Edison Company is, to my mind, the most important aid to new-business-getting we have.

We use the *Handbook*, or "Hint-book," as we call it, as the basis of every agent's initiation into the work with our company. As soon as an agent is taken on to the staff one of these books is made up for him, including every hint up to date. He is expected to give this careful study and to supplement the information he gains there by asking questions of his superiors. He is also sent out to learn by observation how the work is done by agents who have already become familiar with the business. In this way he ought to have a good working knowledge based upon the *Handbook*, and he can turn to the latter any time for all details that he may wish to know.

Besides furnishing these handbooks to the agents we also provide every one in the company who is interested in business-getting and keeping, with a set of the hints, thus enabling them to keep in touch with any changes that may occur in the routine of the business. Wiring contractors and dealers in electrical supplies are also given such hints of a general nature as will keep them informed and will stimulate a mutual interest in the business.

Some agents who deal frequently with customers carry their *Handbook* with them all the time and keep very familiar with its contents, and these get the most advantage from it; others keep it in their desks and freshen their memory occasionally, using it more as a book of reference. Each agent, however, is held responsible for knowing all the hints and for following out their directions.

Mr. L. D. Gibbs related some "Practical Experience with the Handbook." Mr. J. D. Kenyon spoke somewhat at length upon the "Education of the Salesman." The following are some of the main features of his discourse:

The salesman must first understand himself as far as possible; know what his powers are, how to train the undeveloped powers and how to apply them. Self-knowledge is, and will always be, the most important element entering into salesmanship. Next, the salesman must understand people—human nature. He is not dealing simply with mechanical details; he is not dealing with inanimate objects wholly, but he is dealing particularly with human minds, and his mission is to convince or persuade the minds of others to agree with him. And third, he must have a knowledge of his goods. The more thorough that knowledge, the better, and yet it is true that a man may be thoroughly posted on all the technical details of the goods which he is handling, and will be unable to so explain these to others that he will be a failure as a salesman. So let us for the moment go back to the first proposition, the salesman himself, and see what is the source of his power.

We find at the start that his ability to inspire confidence is one of the most important elements entering into the question. Upon analysis it is found that the ability of the salesman to inspire confidence rests primarily on his personality; that personality is the result of the visible expression of character and health. By character I do not mean simply being good. There are lots of good men, men who are too good to do much evil, but who have only a wishbone instead of a backbone—they lack force. Character means something more than being good. It is the result of the development of the positive qualities and faculties of the mind * * * The negative of faith is doubt, and doubt has killed more successes than all the armies of the world have killed men. Let a man doubt himself, his firm, his goods, or the customer, and

he can't help but show it in every move he makes. But a man of faith is the man who convinces.

We now come to a very important part of the salesman's knowledge, and that is the detailed knowledge of his profession. A man, to convey a correct impression to another mind, must possess a good knowledge of a subject himself. We simply transfer mental pictures through the medium of speech, of gesture, and so on. If our own impression is a poor one, we can not transmit a good one. A man with a poor knowledge of the selling points of any proposition cannot fail to be a poor business-getter and a poor business-builder. He may make a spurt here and there by means of a combination of circumstances, but he will not last. Therefore the necessity of training along the lines of acquiring all the knowledge possible in reference to the goods sold.

* * * The salesman must not only know the proper sequence of points, but he must study the methods of expressing these points, in clothing them in proper language to fit the customer, in the use of his voice, in gestures, attitudes, and so forth. Some men talk so fast that it is impossible for minds that act slowly to grasp their ideas. Others make the mistake of talking too slowly to people whose minds act quickly and who lose patience. In some cases very simple language should be used, the voice should be very low and smooth; in some instances little need be said, in others, much. The salesman must have his points so marshalled that he will be able to use them when occasion demands as a general marshalls his troops at strategic points. And finally, a salesman, to become scientific, must have knowledge of at least some of the natural laws by which the mind is governed. For instance, he must realize that in order to persuade a customer to purchase goods there are four steps through which the mind of the customer must pass before the deal is closed. The first step is attention. If he does not get the mind of the customer to concentrate on what he is selling he is losing time. The next step is interest. If the customer does not become interested, there is nothing doing. But there is another step, and that is desire. The customer must be made to want the goods. Still there is nothing doing unless the customer arrives at a decision to buy. Evein here the salesman can make a mistake if he is not able to detect this stage (which is the so-called "psychological moment") and deliberately talk the customer out of the sale. It is true that just as many sales are lost by over-talking as under-talking.

On the general subject of advertising, Mr. E. S. Marlow treated "Advertising Results Demonstrated." Mr. Marlow very properly calls attention to the lack of effort or attention given to determining the actual results of advertising:

The question of "advertising results demonstrated" is certainly a very important one to central-station officials. Because of its importance your reporter states with regret that out of 47 requests for information he received but 10 replies, only a very few of which contained information that would lead one to believe that a systematized effort had been made to keep track of results and thereby in a measure ascertain the relative value of different media as applied to the conditions that exist or will arise.

Your reporter suggests that the various members take this question up individually and that they endeavor during the coming year to keep an account of the results which they are able to trace, so that a committee—if one be appointed to investigate, or if not, the reporter on this subject for the next convention—may be able to give information of a tangible nature when the matter is again presented.

Your reporter would also suggest that the questions be framed and submitted as far in advance as possible, as the various advertising managers would then have an opportunity to answer in a fairly definite way, and the report on the subject would form a guide for future advertising investments.

"How to Make the Most of Newspaper Advertising," was the question which Mr. A. H. Mackie attempted to answer. The fundamental rules which Mr. Mackie lays down will be accepted without question by all who had any practical experience with newspaper or periodical advertising:

Bear in mind that the public is busy and has many self-interests. It is not going to search through the papers for your advertisement. It, therefore, behooves you, Mr. "Ad. Writer," to make your newspaper talks short, sharp and to the point, so that

upon the paper being opened your advertisement stands out and catches the eye. This does not necessarily mean large space, but it does mean plenty of white space and plain black type with a bold headline or two, and then your subject in a few "to-the-point" sentences written as you would speak them to cover some individual case. A clear, attractive cut bearing on the article advertised is always good.

We wish to call particular attention to the summing up of the whole paper in a single line, which we have taken the liberty of emphasizing in our own way. We have laid particular stress upon the last word. There is probably no defect in the wording of an "ad" more fatal than the failure to stop when the point which it is desired to impress upon the reader has been made. The addition of such matter as anyone with ordinary common sense would take for granted, such as "correspondence solicited," "write for terms and prices," etc., form an anti-climax which seriously weakens a well constructed "ad." The prime object of an "ad" is to set the reader to thinking, not to do his thinking for him. "Then—*be brief. Have something to say*—SAY IT—STOP."

"Measuring the Results of Advertising," was ably handled by Mr. M. A. Seelmann, Jr. The paper was illustrated with examples of illustrated advertising and "follow-up" literature. Summarizing the subject, Mr. Sealmann says:

There are two well-defined divisions into which all central-station advertising naturally falls: general educative advertising—the planting of the propaganda—and direct-by-mail advertising—the reaping of results.

The volume of results necessarily depends on two items: vitality of the lists and effectiveness of the advertising. In Brooklyn the workings of this system have proven highly satisfactory. For example, let me cite results from follow-up advertising in the latest month for which figures are obtainable at this writing—April, 1907. During this month the bureau completed the work of sending follow-up literature to ten lists, comprising 1660 names. One hundred and three of the 1660, or 6.2 per cent., signed contracts during April alone. Of these 29 were the direct result of post-card returns, while 74 were signed as the result of special solicitation (coincident with or immediately following and co-operating with the advertising) directed and supervised from the office.

This result was not gained from virgin soil, but in a territory wherein careful solicitation had been carried on for years, and which had been previously exploited by a number of well-directed advertising campaigns.

Mr. Lawrence Manning discussed "The Value of the Service of the Advertising Agency or Specialist" in support of his claims for the advantages of the advertising specialist, Mr. Manning cites the following:

One of the strongest arguments to which the advertising agency or specialist can point as to the effectiveness of advertising, is the wonderful increase in the number of central stations that carried on comprehensive advertising campaigns during 1906 as compared with 1905, which I attribute as the direct result of their efforts through the medium of advertising matter sent out by them to the central stations, which was brought about and made possible by the work of the Co-operative Electrical Development Association, which has been so ably fathered by Mr. J. Robert Crouse, to whom, I think we shall agree, no end of credit is due.

Following are a few figures showing the increase in advertising carried on during 1906 by the central stations as just referred to, which are taken from data obtained and compiled by the Co-operative Electrical Development Association as taken from reports obtained from 943 plants throughout the United States. There is an increase of 65 per cent. in the number of new-business departments organized in 1906 over 1905. One hundred and sixty-five plants added solicitors in 1906, totaling 331, solicitors to follow and back up their advertising and to obtain the greatest benefits from it. During the year over 11 times as many plants began direct advertising as did previously, and 8 times as many began newspaper advertising as did previously, and during 1906 the advertising appropriations were increased by 195 of the plants reporting. For the 43 plants reporting an increase in appropriation in

dollars the total is $42,250.00; and 33 plants reported increase of appropriation for the year in percentages varying from 25 to 615 per cent. for the different states in which the plants are located.

During the year 165 plants opened up display-rooms to further supplement their advertising, which is an increase of more than 330 per cent. over the number of display-rooms opened up previously.

"Display Room and Demonstration as Business Getters," was the subject of an illustrated paper by Mr. E. R Davenport. Mr. Davenport's observations were based upon actual experience, and therefore worthy of serious attention. Among the points brought out are the following:

To obtain the best results, the display-room should be located in a store on a prominent street, with large show windows brightly and attractively lighted, and kept open evenings. Manufacturers are generally willing to co-operate, and apparatus can be secured from many of them on consignment, as it gives them an opportunity to show their goods under most favorable conditions. Local concerns, however, should be given preference, as it tends to create a feeling of good will and co-operation on their part, which should be encouraged. Needless to say, everything electrical should be installed, connected and ready for demonstration at any and all times. It is desirable to have in operation as many working exhibits as possible, such as pumps, coffee mill, meat chopper, Gray telautograph, forge blower; also sign flashers, self-flashing lamps, and so forth. Everything should be up to date. Apparatus out of order should either be repaired promptly or removed and nothing obsolete allowed to remain.

A capable man should be selected to take charge—one who is thoroughly familiar with the details of every device exhibited —and with assistants equally well posted. Young women as demonstrators on domestic appliances are usually the most satisfactory. They should be of good appearance, able to talk interestingly and convincingly, and be enthusiastic over the merits of the devices shown. It is also essential that all of the attendants have at least some of these qualifications.

The show window is of the utmost importance and should be carefully and thoughtfully planned to make it as attractive as possible. Upon it largely depends the number of people visiting your display-room. Don't confine your demonstrations only to good revenue producers, but take the Gray telautograph, the commercial graphophone, and other devices, giving you the variety necessary to stimulate and hold the interest of the public. It is also a good plan to have in your window some attraction after the premises are closed. A large Holophane hemisphere (about 20 inches in diameter), with self-flashing colored lamps arranged to burn all night, gives a very pretty effect and will attract the attention of the passer-by to the window. This can be replaced with the winking owl, and other novelties from time to time. Different methods of window lighting can be advantageously shown in your windows, and the wiring arranged so that one method of a kind can be shown at a time to an interested merchant.

"New Business by Indirect Methods" was treated in a paper by Mr. L. D. Mathes, in which he described a very successful public demonstration of the advantages to be obtained by the use of electric current:

The Union Electric Company, of Dubuque, has for the past two years made a special effort to secure additional connected load from the residential districts.

The company concluded that with all the word-paintings, illustrated matter, and so forth, that had gone from its office to the prospects it was about time to give the public at large an ocular demonstration. It came to the attention of the company that the Household Economics Division of the Dubuque Woman's Club was ambitious to enlighten the public along the lines of domestic science. Knowing that the club would not consider lending its name to any movement that was plainly based on commercialism, the company made a proposition, which, stated briefly, was as follows:

We, the company, will take care of every item of expense involved in a 15-day series of lectures and demonstrations, provide the demonstrators, tools, appliances and foodstuffs required, and undertake all expense of entertainment of the lecturers who may respond to an invitation of the division. The movement will be announced as under the sole direction of the division; company's name will not be featured, or, in fact, appear in any manner unless it be on some of the advertising matter that will

be given to parties interested in the appliances shown. The company's object is entirely educational—no price tags will be attached to any electrical device and no prices quoted unless requested, the idea being that the company's benefits will be indirect, following the wake of such interest as may be created through the lectures and exhibits.

This arrangement having been effected, the company secured a storeroom on the main street in the heart of the commercial district. The room was 40 feet front, 125 feet deep, with a 16-foot ceiling and two handsome plate-glass show windows.

The first and most important feature was the construction of a model six-room cottage. This cottage was a complete structure in every detail except the extension of the shingle roof beyond the center of the peak, as shown in photograph taken from the front. The rooms were finished with tongue-and-groove material of first quality, and the color scheme carried throughout as if for actual occupancy. The furnishings were complete in every detail, electricity naturally being featured. On the porch was shown a 16-cp. lamp enclosed in a ground-glass globe with a metal vine-and-leaf design encircling the same. At the front door was regulation push-button for bell, the hall was well lighted with ground-glass ball, same containing a 32-cp. lamp. The idea being to show effects which were not extravagant, thereby catering to the popular demand, simplicity and efficiency were more of a consideration than any other. The parlor had a simple three-light fixture, luminous radiator, and on a pedestal in one corner was a banquet lamp of neat design. The bed-chamber was equipped with two two-light brackets, a turndown night-lamp on a small table, which also carried an electric milk-bottle warmer and a heating pad. An electric curling iron found a place on the dresser, and attached to the head of the brass bedstead was a special reading lamp with chain pull socket.

The dining-room color scheme was red, white and black. On the ceiling were four frosted lamps in the form of a square around a handsome art glass centre-piece suspended by a chain over the dining table. The ceiling lamps were fitted with red paper shades, a Japanese conceit, which harmonized with the rug and centre piece. In the dining-room was a fully-equipped breakfast set; it contained a coffee percolator, a toaster, a large chafing dish, and a small stove for use in connection with one of the several extra utensils. During the demonstrations this set was very effectively shown in service, the idea being to illustrate the readiness and ease with which a substantial breakfast could be prepared and served in the dining-room.

The library, or den, carried two complete lighting schemes. In moments of lassitude a delightfully restful sensation would be induced through the subdued effect of the red art glass lamp on the centre table, on which was also placed the smoking set. When general illumination was required, it was well provided for through four 16-cp. lamps on the ceiling, same being enclosed in ground-glass balls.

The pantry had one lamp in the centre, equipped with a two-ball adjuster which would permit the housekeeper to carry the light to any point desired in the room. In the kitchen was shown an electric cabinet with all appliances. The furnishings were provided by the dealers of the city, who contested most spiritedly for the privilege of contributing their choicest stock for the demonstration.

In addition to the devices above described, there was a handsome display of banquet lamps and general lighting effects, as well as domestic utilities, by a local electrical contracting firm. This firm was admitted at the request of the lighting company, with the understanding that it would attempt no sales, though prices could be quoted to inquirers. The only advertising shown in the hall during the series was the sign of the contracting firm and in one section or corner of the hall a group of cards stating that the various furnishings were from the firms whose names were mentioned. The only paid advertising in connection with the announcements of the lectures and demonstrations, consisted of a double-column five-inch space inserted in the three daily papers and carried throughout the course.

Each of the papers devoted from a half to a column and a half of reading matter each day in a recitation of the progress of the work. The company's scrap-book contains over 50 columns of solid reading matter, all of which the newspapers were glad to publish from the fact that it was regarded as live news matter.

Within 15 days following the demonstrations, the contractor who had an exhibit placed on his books 16 house-wiring orders. The contractor and the company have received orders for 6 sewing-machine motors, 18 electric irons and 12 to 15 pieces of miscellaneous heating devices. In addition to

this some 30 or 40 residential contracts are being figured, with every indication of the greater percentage being closed. We feel that the results will filter in for a year, and possibly during the next two or three years additions to the connected load will come in as the result of the late demonstration.

Concerning the cost of the movement, detail of the same is submitted herewith:

Cost of Demonstration.

Printing and advertising	$112.57
Demonstrators, assistants, and expenses of same	366.66
Supplies for demonstrator and caterer	190.60
Watchmen	83.45
Miscellaneous expenses	165.07
Construction and finishing cottage.	360.75
Total	$1,279.10

As an indirect method of enlisting the attention and interest of the desirable classes, this company feels that the plan as briefly outlined in this statement will prove effective even though same may be materially modified.

Mr. George Steinwedell gave his experience along similar lines in the city of St. Paul. As to the results of demonstrations of electrical devices made at two popular "fairs," Mr. Steinwedell says:

The amount of new business these shows were the indirect means of securing and holding is extremely difficult to calculate. The interest in the show and in the company's exhibit, and the number of people it was possible to reach in a convincing way, would hardly have been accomplished by any other means. The favorable comment of press and public, and the spirit of co-operation shown by the company toward two bodies of the best business men, can hardly be estimated in dollars and cents. It is considered that the results more than justified the exhibits. Although these results are difficult of immediate analysis, the effect is far-reaching, and the company will reap its reward for a long time to come.

Mr. C. F. Oehlmann, the illuminating engineer of the Union Gas & Electric Company, Cincinnati, presented the claims of "Illuminating Engineering as an Aid to Securing and Retaining Business." We give this paper in full:

Illuminating Engineering as an Aid to Securing and Retaining Business

In writing this paper I shall not endeavor to dwell upon the merits of the many makes and styles of incandescent or arc lamps, nor upon the scientific lines of illuminating engineering. These subjects are worthy of careful discussion.

The subject "Illuminating Engineering from a Business-Getting Standpoint" has been and is attracting attention of not only the general management of central stations, but of illuminating engineers, both in the United States and European countries, Germany and England especially. Letters are received daily from illuminating engineers and central stations asking the illuminating engineer to furnish some information regarding the system of work and success obtained.

Mr. Henry L. Doherty was probably the originator of this line of work when a year or two ago he organized a service supervisor department in the new-business department of the Denver Gas and Electric Company under Mr. Clare N. Stannard, new-business manager. The gentlemen acting as service supervisors assumed the duty and responsibility of seeing that present consumers were getting the best possible results or value for the money they were paying for the commodity used. As soon as they saw they had given consumers a higher efficiency on present installation they found it easy to close additional business, and also made a well-pleased consumer.

While these service supervisors were not illuminating engineers, nor did they attempt illuminating engineering beyond the ordinary good common sense that every new-business man should use, they probably installed the idea of the illuminating engineer in connection with the new-business departments. The illuminating engineer is a recent character, not probably more than four years old. The business-getting illuminating engineer is a very recent character, and the work has progressed only far enough to enable one to form but a fair idea of the value of this work. The daily and monthly reports of the illuminating engineers show a decidedly profit-

able work, and the annual report will no doubt demonstrate very thoroughly, even to the most sceptical, that the illuminating engineer working in connection with a new-business department is most desirable.

The work of the illuminating engineer is not only to call upon architects, contractors and owners of new buildings, to adjust complaints by the rearrangement of what has been a poor lighting scheme, to educate the electrical wiremen to the economy of electric lighting from an illuminant standpoint, but to educate the representatives and salesmen of the new-business department. The latter is the real work of the illuminating engineer and is what makes his work valuable to the central stations. This work may be accomplished in many ways, but the real object is to have the representatives advise with consumers and prospective consumers, making proper suggestions as to the actual necessary installation, neither too much nor too little. Mr. Doherty once reminded the writer that an engineer was a man who could do with one dollar what an ordinary person would use two for.

Representatives making the mistake of advising too much light are in far greater error than in advising too little and are more to be feared, inasmuch as it results in a complaint from the common cause, a high bill, and means either a discontinuance of service or a special rate; and I should like to say at this time that I would prefer to lose the business rather than to make a concession in the rate, thereby admitting my rate to be in error.

The salesmen and representatives of the new-business departments should be familiar with all new reflectors marketed, both concentrating and diffusing, and also the perfect use of same. They should know how to place lamps and sources of light to the best possible advantage from an illuminant standpoint, should know some of the general principles of illuminating engineering, and should also know how to figure cost of operating and maintaining installations of all kinds. These things should all be taught by the illuminating engineer. The illuminating engineer should spend half a day as often as possible with each representative in his respective territory or district, going to different stores, residences, halls, churches, and so forth, and advising with the representatives as to the best plan of illumination. These half days with short lectures each week and daily discussions of new lamps and reflectors will constitute a splendid means of educating the new-business department men and place the illuminating engineering feature on a par with any work being accomplished by the various central stations.

"Methods of Securing Residential Business," was discussed by Mr. R. C. Hemphill, Jr. He divided the methods into two general classes: canvassing and advertising. As to canvassing he offers the following suggestions:

The first step is to gather the data necessary to lay out a campaign. Select from among your employees two or more good-looking, bright-witted chaps, dress them up in their best clothes and send them out to make a house-to-house canvass.

The line of talk these canvassers are trained to give during this preliminary canvass is as follows: They call for the lady of the house. "Madam, I am the representative of the electric company. Do you have our service?" "No, we use gas." "Can I not interest you? A number of your neighbors are using our service. Our rates have been materially reduced, and the management thought that this spring you would be interested in having us explain its advantages."

If he finds the house is connected on our circuits the talk runs something like this: "I am a representative of the electric company and called to see if our service is entirely satisfactory, and if there is anything we can do for you. The management wants your co-operation in giving good service, and if you can suggest anything along that line we will be glad to hear of it."

It is certainly astonishing what a pleasant feeling is at once established between the company and the consumer, indirectly paying more than the entire cost of the canvass.

In regard to advertising he says:

We carry on various advertising campaigns, trying to supplement the work of our canvassers.

First—Newspaper Advertising. We carry a double-column, five-inch space with each daily paper, changing the advertisement every week.

Second—Direct-by-Mail Advertising. We mail to 50 per cent. of our residences monthly bulletins. We get good results not only by pleasing our present customers but also in getting others to discussing various appliances.

Third—Exhibition-Room. We have in connection with our office a large display window and exhibition-room, kept attractive by frequent changes. We endeavor each month to adopt a special feature, as for instance:

January, small-cp. and Hylo lamps.
February, motors.
March, fixtures.
April, irons.
May, cooking and heating appliances.
June, fans.

And so on during the year. We endeavor to have on exhibition and in operation every article mentioned in our advertising or spoken of by our canvassers.

Fourth—We endeavor during April of each year to give a week's practical demonstration of heating and cooking devices. In conducting a demonstration the chief aim should be to give it tone. The class of people you want to attend is not the class that goes to free exhibitions, and the class that goes to free exhibitions is not the class you want.

"Coöperative Lighting of Streets by Merchants," was ably treated by Mr. H. J. Gille. His observations were based upon experience with the problem as carried out in St. Paul. As this subject is one of special importance not only to illuminating engineers, but to central stations and municipalities as well, we reprint the paper nearly in full.

Business men, as a rule, appreciate the benefit derived from something out of the ordinary, especially if it has strong advertising merits. If business men are public-spirited anything that will advertise the city in which they are doing business will appeal to them, especially if they derive direct benefit from it.

I will not enter into a lengthy discussion of the advantages to a city and to the merchants of ornamental street lighting, which must be apparent to all who have given this subject attention, but will give the methods employed in developing this system in St. Paul.

The co-operation of the merchants necessary to carry on a lighting scheme of this kind was accomplished by means of improvement associations. The plan in organizing these associations was for several prominent merchants on a street to call a meeting of the property owners and tenants on that street. At this meeting, after stating in a general way the plan of illumination, a committee was appointed to submit designs for posts, plan and location, together with an estimate of the cost. Two committees were appointed in each block, one on each side of the street, for the purpose of getting signatures from property owners and tenants agreeing to pay their proportion of the installation and maintenance expenses—it being understood that the property owners were to pay for the installation and the tenants for the maintenance.

A copy of the agreement used by the various associations in St. Paul is as follows:

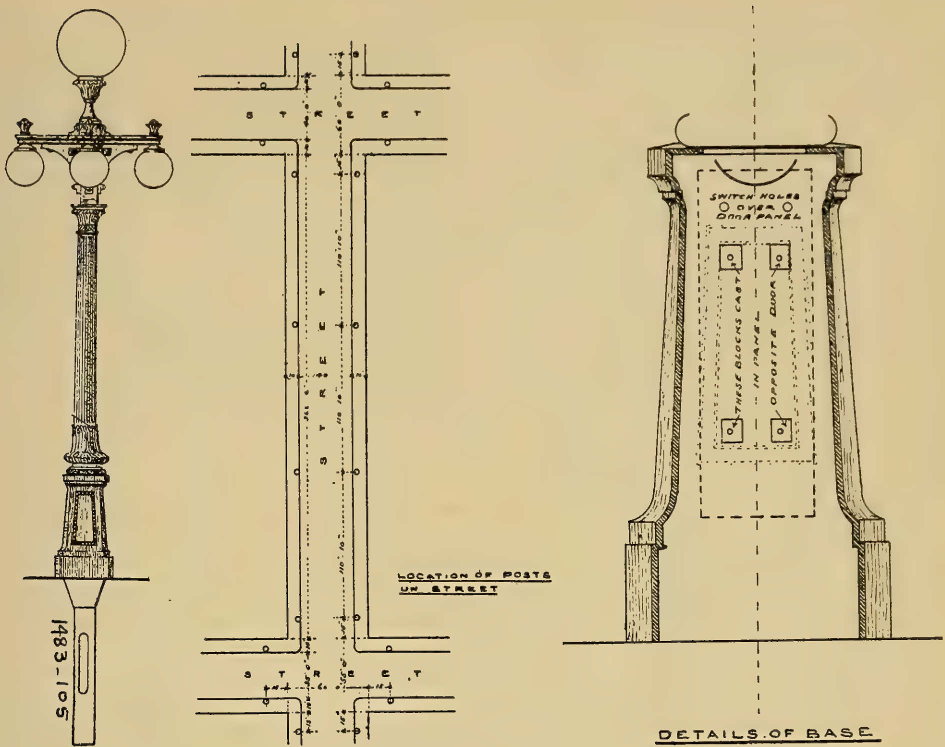
BLANK STREET IMPROVEMENT ASSOCIATION.

AGREEMENT.

We the undersigned, owners of, and tenants occupying, property facing or abutting upon Blank street, in the city of St. Paul, in consideration of the obligation hereby assumed by each and all of us whose names are hereunto attached, do hereby agree to pay our *pro rata* share of the cost of installing and maintaining a system of lighting upon Blank street in accordance with plans to be submitted to us and at an expense to each property owner of not more than one dollar and fifty cents per front foot of installation, and at an expense to each tenant of same of not more than one dollar and thirty-five cents per front foot per year for maintenance.

NAME.	ADDRESS.	NO. FEET.
....	....	....

After the signatures of property owners and tenants were secured another meeting of the committees was called which authorized the officers of the association to contract for the installation and maintenance. The improvement associations have contracted with the foundries for the post and with the St. Paul Gas Light Company for erecting, glassware, wiring, lamps, and so forth. The St. Paul Gas Light Company made an agreement with the association to collect from the tenants for them the money for maintenance and to credit the amounts to the associations' accounts. Approximately 20 per cent. more than the actual cost of lighting per foot is collected in order to provide a contingent fund to take care of accounts that cannot be collected owing to vacant stores or tenants that will not pay. This contingent fund is to be rebated *pro rata* to the subscribers at the end of the year. The city pays the



FIGS. 1, 2 AND 3.

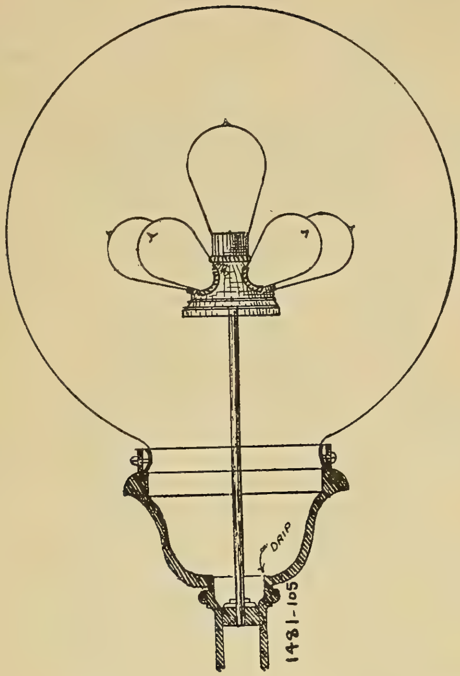
same amount for lighting that it paid under the old lighting system, thus reducing the cost to the tenants by the amount collected from the city.

St. Paul has at the present time five improvement associations that were organized for ornamental street lighting which covers about four miles of streets in the business district, being a total of 250 posts. This system is a radical departure from the methods employed heretofore. In order to have a good distribution of light and at the same time secure proper artistic effect combined with illumination, a plan was adopted of placing eight ornamental iron posts to each block, four on each side of the street, as shown in Figure 2.

Figure 1 is an illustration of the post. The top globe is light opal, eighteen inches in diameter, in which is one 50-cp. lamp surrounded by five 10-cp. lamps. The globes hanging pendent on four side-arms of the post have four 10-cp. lamps each and are 12 inches in diameter, making a total consumption of 811 watts per post. It is the intention, however, to substitute high-efficiency lamps later. The 50-cp. lamp in the top globe is on a separate circuit from the other lamps, for the reason that it burns all night while the other lamps are turned off at midnight. The lamps are operated from the Edison 3-wire network and are turned on and off by patrolmen. Two circuits are controlled by snap-key switches, the keyholes being in the base of the post, as shown in Figure 3. In order to provide for the heavy wind pressure against the globes, a brass collar is used around the neck of each globe to distribute pressure of the thumbscrews with which the globe is held. The wiring of the cluster is brought up through a pipe, as shown in Figure 4. Drainage is provided for any water caught in the top globe holder. The post is wired on the inside in circular loom, and connections to the underground mains along the street are made through lead-covered cable buried in concrete. The inside of the post is filled with concrete up to the level of the door in the bottom.

The cost for posts installed is $100 each, of which $55 is cost of foundry work and $45 for installation, connections, wiring, globes, and so forth. The posts are 14 feet high over all and extend four feet below the sidewalk, set in concrete. The post

ness was selected and worked upon until he lighted up. He was then used as a pacemaker for other merchants. When his rivals installed lights the pioneer in the field was induced to increase his display. It is a noteworthy fact that the merchants who use this form of advertising are continually increasing their original installation.



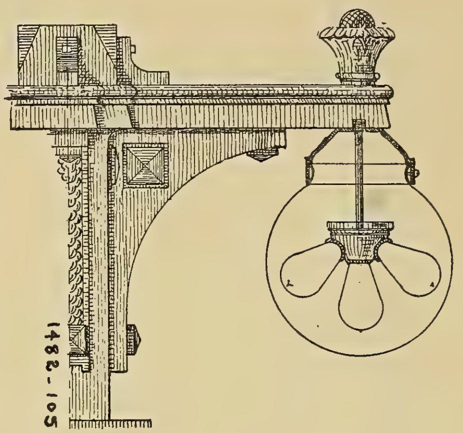


FIG. 4.

is all one casting, except the arms at the top, which are bolted on. The arms are 18.725 inches long from center of post to centre of lamp cluster. The base of the post is 16 inches square by 30 inches high. The post below the sidewalk is 6 inches square and is provided with an opening for the cable.

The cost of maintenance and lighting is $101 per post per year. This is equivalent to approximately five cents per kilowatt-hour.

This uniform system of lighting has added much to the appearance of the streets on which it has been placed, without detracting from the window display and signs, which is quite important with any street-lighting system.

Methods of securing sign, outlining and window lighting were briefly set forth by Mr. Homer Honeywell. Mr. Honeywell evidently believes that advertising, like charity, should begin at home.

We set a good example by outlining our building, lighting up the windows and installing the largest electric sign in town.

A good live prospect in each line of busi-

U. S. Government Specifications for Incandescent Electric Lamps

Samples.

To show construction, bidders must, if requested, submit two samples of each type of lamps proposed to be furnished. All lamps must conform to the samples submitted, in shape of bulb, in mechanical construction, and type of filament, and no departure from the sample lamps will be allowed without written permission.

The successful bidder shall furnish, for check and use in inspecting lamps, not less than four primary standard lamps. These lamps will be returned to the contractor on completion of contract.

Comparative Tests.

In determining the award of a contract bidders may be required to submit for a comparative test 500 lamps. Such test will be conducted with a procedure similar to that outlined in these specifications for inspection and tests of lamps ordered under contract, modified as follows:

(*a*) Inspection of 50 per cent. of each lot of 500 lamps to discover faults in construction and sorting.

(b) A determination of the uniformity,

or non-uniformity, of rating and the characteristics of the distribution of light of the lamp, including the measurements of about 100 lamps of each lot of 500 to determine the mean horizontal, tip, and mean spherical candle-power, together with the current consumption.

(*c*) Determination of mean spherical candle-power performance throughout the useful life of 25 lamps of each lot of 500 submitted, operated at voltage corresponding to an initial specific consumption of 3 watts per mean spherical candle.

Standard Incandescent Lamps.

Incandescent lamps to be furnished under this contract shall be new lamps and shall be guaranteed to be in accordance with the following specifications:

General.

The provisions of these specifications shall be binding upon all lamps specifically mentioned herein, or in schedules, by voltage, candle-power, watts per candle, type, and base, and upon no other lamps, except by mutual written agreement.

These specifications shall not apply to any frosted, colored, or other lamps than with the usual clear-glass bulbs, unless otherwise specifically included. Frosted lamps shall be represented in initial tests, inspection, and life tests by bare lamps selected from the lots before frosting.

All tests shall be made, in a competent and expert engineering manner, at the expense of the Government, excepting that when initial inspection and tests are made at the factory the contractor will be required to supply the necessary equipment, assistance, current, and facility for making the tests. The manufacturer, or his agent, shall have the privilege of witnessing and verifying all tests of his lamps made hereunder, and shall also be privileged to obtain copies of the tests of his lamps and have access to the records of such tests at all reasonable times.

The Government reserves the right to modify the method of test procedure in any particular whenever such change is desirable to secure test results in a more practicable, representative, or accurate manner. Such changes will be made, however, with the full knowledge and consent of contractor.

Definitions and Standards.

Unit of candle-power.—The unit of candle-power shall be the candle as determined by the Bureau of Standards at Washington, D. C.

Photometric measure.—The basis of comparison of all lamps shall be the mean spherical candle-power. The nominal candle-power referred to in these specifications shall be the mean horizontal candle-power of lamps having a mean spherical candle-power value of 82.5 per cent. of the mean horizontal candle-power, which is the standard value for filaments of the oval anchored type.

For lamps having filaments giving a different ratio of mean spherical to mean horizontal candle-power, the horizontal candle-power measurement will be corrected by a reduction factor determined by the Bureau of Standards or other authority mutually agreed upon.

Test quantity.—The test quantity shall consist of 10 per cent. or more of any lot or package, and in no case be less than 10 lamps.

Method of Test.

From each package there will be selected at random the test quantity for the purpose of determining the mechanical and physical characteristics of the lamps, the individual limits of candle-power and watts, and finally the life and candle-power maintenance. These lamps will be known as the test lamps.

Mechanical and Physical Characteristics.

All lamps shall conform to the manufacturers' standard shapes and sizes of bulbs, and to the standard forms of filament, and the standard candle-power and watt ratings.

Bulbs.

All bulbs shall be uniform in size and shape, clear, clean, and free from flaws and blemishes.

Bases.

All lamps, unless otherwise specified, shall be made with moisture-proof standard Edison screw bases, fitted with glass buttons. The shells of the bases shall be of good quality brass, firmly and accurately fitted to the bulb with moisture-proof cement, and in length to conform to the Electric Code of the National Board of Fire Underwriters.

Filaments.

The lamp filament must be symmetrically disposed in the bulb and shall not droop excessively during the life of the lamp, when the lamp is burned on test without excessive vibration and in one horizontal position at a voltage corresponding to an

initial specific consumption of 3.76 watts per mean spherical candle.

All filaments must be uniform and free from imperfections, spots and discolorations.

Leading-In Wires.

Leading-in wires must be fused into the glass with the joints between the copper and platinum wires bedded well within the glass, and must be straight, well separated, and securely soldered to the base and cap, without excess of solder. The threads of the base must be free from solder.

Vacuum.

All lamps must have first-class vacuum, showing the characteristic glow of good vacuum when tested on an induction coil.

Marking.

A printed label, showing manufacturer's name or trade-mark, voltage, and candle-power, must be placed on each lamp near base.

In General.

The lamps must be well made and free from all defects and imperfections, so as satisfactorily to meet the conditions of the lighting service.

Rejection for Defects.

If 10 per cent. of the test quantity of lamps selected from any package show any physical defects incompatible with good workmanship, good service, or with any clause of these specifications, the entire lot from which these lamps were selected may be rejected without further test when tests are made at the lamp factory. When the tests are made elsewhere, if the first test quantity proves unacceptable, 20 per cent. more lamps will be selected from the package or lot of lamps, and should 10 per cent. of this second lot of sample lamps be found to have any of the physical defects above mentioned, the entire lot from which these samples were selected may be rejected without further test.

Initial Limits.

When tested at rated voltage, the test lamps shall not exceed the limits given in the schedule. If 10 per cent. of the test lamps from any package is found to fall beyond the limits stated, when tests are made at the lamp factory, the entire lot from which these lamps were selected may be rejected without further test. When tests are made elsewhere, if the first test quantity proves unacceptable, 20 per cent. more lamps will be selected from the package or lot of lamps, and should 10 per cent. of these additional lamps be found to fall beyond the limits, the entire package may be rejected without further test.

Life and Candle-Power Maintenance.

Life tests shall be made as follows: From each accepted package of lamps, two sample lamps shall be selected which approximate most closely to the average of the *test quantity*. One of the two lamps thus selected will be subjected to a life test and designated as the *life-test lamp*, the second or duplicate lamp being reserved to replace this *test lamp* in case of accidental breakage or damage during the life test. *The test lamps* shall be operated for candle-power performance at constant potential, average variations of voltage not to exceed one-fourth of 1 per cent., either side.

The voltage for each lamp shall be that corresponding to an initial specific consumption of 3.76 watts per mean spherical candle, or if tested upon a different basis, the results shall be corrected to a basis of 3.76 watts per mean spherical candle. If desired, the life tests may be made at such other watts per candle as may be mutually agreed upon.

Readings for candle-power and wattage shall be taken during life at the market voltage of the lamps at approximately fifty hours, and at least every one hundred hours afterwards until the candle-power shall have fallen 20 per cent. below the initial candle-power, or until the lamp breaks, if within that period. The number of hours the lamp burns until the candle-power has decreased to 80 per cent. of its initial value, or until the lamp breaks, if within that period, is known as the useful or effective life.

The average candle-power of lamps during life shall not be less than 91 per cent. of their initial candle-power. In computing the results of test of a lot of lamps the average candle-power during life shall be taken as the arithmetical mean of the values for the individual lamps of the lot tested.

Lamps selected for the life test, which for any reason do not start on such test, shall be replaced by others.

On all tests for determining average candle-power and life each package which will be affected by the results of test shall have at least one lamp on such test.

Lamps which are accidentally broken but not burned out on test shall not be counted to diminish the average performance.

In case both test and duplicate lamps are broken or damaged before the life test

For 100-130 Volt Lamps.*

Rating.		Initial Limits.				Average Performance.
Rated candle-power, mean horizontal.	Initial watts per mean horizontal candle.	Individual candle-power limits.	Mean candle-power limits.	Individual watt limits.	Mean watt limits.	Useful or effective life in hours to 20 per cent. drop in candle-power at 3.1 watts per candle.
4	4.8	1 c.p. above and 1 c.p. below.	0.6 c.p. above and 0.6 c.p. below.	12 per cent. above and 12 per cent. below.	6 per cent. above and 6 per cent. below.	300
5	4.2	do.	do.	do.	do.	300
6	3.7	do.	do.	do.	do.	300
8	3.1	do.	do.	10 per cent. above and 10 per cent. below.	5 per cent. above and 5 per cent. below.	300
	3.6	do.	do.			330
10	3.1	do.	do.	do.	do.	330
	3.6	do.	do.	do.	do.	390
12½	3.1	do.	do.	do.	do.	390
	3.6	do.	do.	do.	do.	450
16	3.1	7½ per cent. above and 7½ per cent. below.	2½ per cent. above and 2½ per cent. below.	5½ per cent. above and 5½ per cent. below.	2½ per cent. above and 2½ per cent. below.	450
	3.5					420
20	3.05	do.	do.	do.	do.	420
	3.5	do.	do.	do.	do.	350
24	3.1	do.	do.	do.	do.	350
25	3.6	do.	do.	do.	do.	430
32	3.1	do.	do.	do.	do.	430
	3.6	do.	do.	do.	do.	400
50	3.6	do.	do.	do.	do.	300
75	3.6	do.	do.	do.	do.	...
100	3.6	do.	do.	do.	do.	...

is completed, the average performance of all lamps of the same class previously tested under the same contract shall be assigned to the package represented.

Accurate recording voltmeter records will be obtained during the test on lamps to show the average variation on the circuit.

When so tested the average useful life values of the lamps shall be at least as great as those given in the following tables.

(*a*) Values for Oval Anchored Plain Standard Lighting Lamps.

Lamps of this type, of voltage 105 and below, 110, 120, and above, and also 220, may have double the limits of variation in the initial limits specified for their respective classes.

For lamps between 120 and 125 volts, the useful life values shall be 95 per cent. of those given in the table, and for lamps between 126 and 130 volts, the useful life values shall be 90 per cent. of those given in the table.

Lamps of other types of filaments shall give equivalent performances.

(*b*) Values for Round Bulb, Tubular, and Other Irregular Types of Lamps.

The individual limits for irregular types of lamps, such as round-bulb and tubular lamps, shall be twice the individual limits given in the body of the preceding schedules for regular lamps of corresponding candle-powers.

The individual limits for metallized filament and round bulb prismo types of lamps shall be 15 per cent. above and 15 per cent. below the mean candle-power rating, and 15 per cent. above and 15 per cent. below

* It is recommended that every effort be made to avoid ordering lamps of actual rated voltages 105 and below, 109, 110, and 111, 120 and above, and from 218 to 222, inclusive.

For 200-250 Volts.

Rating.		Initial Limits.			Average Performance.	
Rated candle-power, mean horizontal.	Initial watts per mean horizontal candle.	Individual candle-power limits.	Mean candle-power limits.	Individual watt limits.	Mean watt limits.	Useful or effective life in hours to 20 per cent. drop in candle-power at 3.1 watts per candle.
8	4.4	2 c.p. above and 2 c.p. below.	1 c.p. above and 1 c.p. below	15 per cent. above and 15 per cent. below.	7½ per cent. above and 7½ per cent. below.	120
10	4.25	do.	do.	do.	do.	130
16	3.8	15 per cent. above and 15 per cent. below.	7½ per cent. above and 7½ per cent. below.	12 per cent. above and 12 per cent. below.	6 per cent. above and 6 per cent. below.	
					do.	160
20	3.8	do.	do.	do.	do.	160
24	3.8	do.	do.	do.	do.	150
32	3.8	do.	do.	do.	do.	150
50	3.8	do.	do.	do.	do.	120

the mean total watt rating. The candle-power ratings referred to are the mean horizontal candle-power ratings of clear lamps without reflectors.

Rejections and Penalties.

The failure of the lamps in any package to conform to the specifications as to mechanical and physical characteristics, or to initial limits, may cause the rejection of the entire package.

The failure of the lamps to give within 90 per cent. of the values of useful life given in the tables may cause the cancellation of the contract.

Lamps which have not been used and are rejected under the terms of these specifications will be returned to the manufacturer at his expense, and no payment will be made therefor.

Prompt notice will be served upon the contractor of the test results on lamps that are rejected, or that fail to meet the specified requirements.

$2,600.00 in Prizes for an Electric Solicitor's Handbook

The following extract from a paper by Mr. R. S. Hale, of Boston, on "The Value and Use of a Solicitor's Handbook" will be of interest to those who are already competing for the prizes as well as to others who may now contemplate to do so.

"I want now to make a brief announcement of a change in plans in connection with the prize contest for the best electrical solicitors' handbook. The Co-operative Electrical Development Association wrote to all of those who had manifested an interest in the proposed contest last April to find out how they felt about an extension of time in which to submit the competing books.

"By general agreement the time was set for October 1st, next, and all of the competitors must have their work turned in to the Co-operative Electrical Development Association, Cleveland, Ohio, by that time.

"I am sure you all appreciate the value of this contest to central stations and others because of the stimulating of interest everywhere and a fixing of the minds of a great many agents upon the details of their own handbooks through a desire to think up some way by which they could get into this contest.

"I hold in my hands a New York draft for $2,600.00, which represents the total amount to be awarded in prizes to the successful competitors in this handbook contest. The money will be placed in a bank where it will draw interest until the time the awards are made in October, so that the winners will not only get their prize money, but interest on it as well."

Correspondence

From Our London Correspondent

Last month an exhibition of an international character was opened in Dublin, the capital of Ireland. Some of the exhibits in the Gas Pavilion are of interest to the illuminating engineer, and a short reference to them will not be out of place.

Messrs. Sugg & Co. have been entrusted with some considerable section of the outdoor lighting. For these lights the pressure of gas has been raised in order to give 16 inches column of water, below the burners, it having been found that at such pressure the best results have been obtained. Two of Sugg's No. 6 pressure increasers are used; these consist of a gas engine, and the pressure increaser, fixed upon a cast-iron base plate, with gas container, governor, etc. The plants can be worked singly or together. For the purpose of illumination there are ninety-four wrought iron columns surmounted with Belgravia lamps of 1,500 candle-power; the aggregate illuminating power being 141,000 candles. The arrangement of the lamps is shown in Fig. 1. Each lamp is fitted with three 500 candle-power high-pressure burners, arranged to "light up" instantaneously from one point, each lamp being fitted with Sugg's mercurial seal, which ensures the gas services being kept fully charged when the gas is turned off from a distance, so that when the main cock is again turned

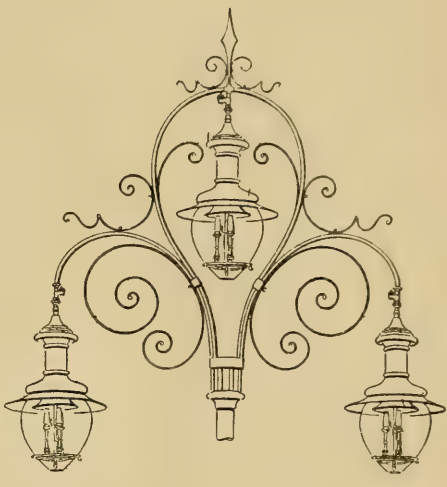


FIG. I.

on, the burners light instantly and the risk of the flash lights being extinguished by a rush of air is completely obviated.

Another section is in the hands of Messrs. Keith & Blackman Co., high pressure gas lighting engineers; this firm supplies one hundred and fourteen lamps of 1,500 candle-power. The compressing plant is supplied in duplicate, and consists of two compressors capable of supplying the quantity of gas required; they are each driven by a small gas engine. The pressure as the gas leaves the blowers is 20 inches. The lighting and extinguishing of the whole of the lamps is controlled from the shed in which the compressors are fixed. A double system of supply services has been arranged—one pipe supplying

high pressure gas direct from the blowers, and the other taking gas at normal pressure to supply the by-pass, or pilot light. In the head of each column a mercurial seal is fitted which prevents the exhaustion of gas in the mains. The floats of the seal operate at 2 inches, but the pressure of gas at the burner ranges from 16 to 17 inches. The lamps are all fitted with three 500-candle-power burners requiring 16 cubic feet of gas per hour at a pressure of 16 inches; the consumption per hour for the whole installation is 5,700 cubic feet, giving a duty of 171,000 candle-power.

Yet another high pressure gas lighting system is in use known as the "Daco Light," the invention of Messrs. Anderson & Duffield. The apparatus consists of a pair of 1¼ horse-power gas engines with magneto ignition, driving direct rotary pressure raisers of the positive type, each capable of handling 3,500 cubic feet of gas per hour. The gas is discharged into a pressure holder, and from thence it passes into the high pressure main and forward to the lamps. The gas is raised to a pressure of 12½ inches. The plant supplies 63 "Arc" lamps, each providing an illumination of 1,500 candles. A separate low pressure supply is run to the flash light, or pilot light, and the lamps, like those of other makers, are supplied with a mercurial seal, in order that immediately upon the engine being started the lamps are instantaneously lighted.

Probably before this article is published the Annual Conference of the members of the Institution of Gas Engineers will have been held. The meeting this year is in Dublin. Of the papers read, one or two only will interest readers of THE ILLUMINATING ENGINEER; they are: "The Use of Gas from a Hygienic Standpoint," by Professor Vivian B. Lewes; "Incandescent Gas Lighting, with Special Reference to Inverted Burners," by Harold E. Copp; "The Sale of Gas," by Mr. F. W. Goodenough, Chief Inspector of the Gas Light & Coke Co. (London), and "High Pressure Distribution Development in the United States," by Mr. Robert M. Searle, of Rochester, N. Y. We shall hope in due course to call attention to these matters. Our Institution is also to be honored by a paper from Mr. Paul Schlicht of your city, entitled: "The Financial Significance to the Gas Industry of the Modern Coke Oven." This gentleman recently delivered a lecture before the Society of Arts, upon the need for smoke abatement and the desirability of pushing the sale of coke, and, as we understand it, the production of a special coke at gas works. This will hardly accord with the gas maker's view, as coal primarily distils gas, and all other products are subservient and of secondary consideration. In Great Britain coke has never been a popular fuel, and the best use gas makers have put it to is in connection with the manufacture of carburetted water gas.

A series of articles is appearing in the columns of the *Gas Journal* under the heading "Illuminating Truths for Householders." The truths are not the less true because they are not new; for instance, summarizing the experiments made in connection with a report by Professor Percy Frauhland made in 1902, on the lighting of the Birmingham Art Gallery, and the condition of ventilation we are told:

(a) In the absence of any artificial illumination, there is a slight increase in the percentage of carbonic acid in the air of the gallery during the course of the day.

(b) With the electric arc lamp illumination, the increase in the percentage of carbonic acid is distinctly more marked.

(c) With the incandescent gas illumination, on the other hand, instead of there being any increase, there is a distinct diminution in the percentage of carbonic acid in the air.

It is a little far fetched to defend gas from being the cause of blackened ceilings. The writer says: "Where there is a great up-current of heat from a large burner, and the ceilings are low-pitched, it is sometimes found that there is discoloration immediately above, but this is due not to carbon particles from the gas, but to the heat current carrying with it the dust that is contained in the air of the room. There is, so to speak, a constant purifying action going on in this way. That this is true may be found by taking two similar rooms, one of which is rarely occupied, and is kept scrupulously clean and another which is in constant use, with people continuously moving about in it. If the same number of burners going in the room simultaneously it will be found that in the room that is little occupied the ceiling maintains very much its pristine appearance, long after the other, or constantly occupied one, has lost its freshness." "Ain't it wonderful!" Does the writer expect any sane person to believe that when "a room is rarely occupied" the "same number of burners" will be going? At present the most ardent upholder of the advantages of gas as an illuminant freely admits that it is impossible to maintain the "pristine appearance" of white-washed ceilings for any lengthy period, although the combustion of gas burnt in an incandescent burner, properly regulated, is now practically perfect.

Mr. James Swinburne has recently read a paper before the Royal Institution on "Incandescent Illuminants," in the course of which he described the evolution of the gas mantle and the theory associated with it. He said it has been generally assumed that the temperature of a Bunsen burner is too low for a mantle to give the light it does by simple radiation, unless it is much hotter than the flame. Admitting that the temperature of the flame is high, it is still urged that the light given by thoria with a small percentage of ceria, is so great that there is something else than mere thermal radiation. It is said that ceria acts as a catalytic agent, and that it oscillates between two states of oxidation. For instance, if a ceria mantle is put on a lighted burner, and the burner turned out, and the gas turned on again, the ceria mantle will glow and will finally light the gas. Some say that the zirconium mantle will do the same thing, but Mr. Swinburne adds that the zirconium mantle gives very little light. He further remarked that one of the drawbacks to gas, as compared with electric lighting, is that merely turning does not light the gas. The by-pass and pilot light, when connected with the recently perfected "gas switches," partly gets over this trouble; but still a light, however small, has to be kept burning. He called attention to a discovery by Welsbach, that an alloy of cerium and iron gives off sparks on being scraped or filed, and, we understand, that a burner has been designed in which the act of turning on the gas scrapes a little wheel of this alloy, causing a spark which lights the gas. As far as we know this invention has not yet passed out of the experimental stage.

CHAS. W. HASTINGS.

The Illuminating Engineering Society

Announcement of the First Annual Convention

OFFICE OF CHAIRMAN OF CONVENTION.

729 Old South Building, Boston.

GENERAL CONVENTION COMMITTEE.

John Campbell, Chairman; Dr. Louis Bell, N. E.; J. S. Codman, N. E.; Albert Scheible, Chicago; Geo. C. Keech, Chicago; J. R. Cravath, Chicago; G. B. Griffin, Pittsburg; C. W. Ridinger, Pittsburg; J. C. McQuiston, Pittsburg; H. K. Mohr, Philadelphia; I. H. Francis, Jr., Philadelphia; Walton Forstall, Philadelphia; A. A. Pope, New York; A. E. Forstall, New York; Preston S. Millar, New York; V. R. Lansingh, New York.

To the Members of The Illuminating Engineering Society:

PLACE OF MEETING.

On special invitation of His Honor, John F. Fitzgerald, Mayor of Boston, the first annual convention of the Society will be held at Boston, Mass., Tuesday and Wednesday, July 30th and 31st, 1907. The program as to hours and number of sessions, will be announced later, but from the material already in the hands of the various committees and the promise of many additional valuable papers and exhibits, there can be no question of the assured success of the Convention, and its educational value to each and every member.

HEADQUARTERS.

The business headquarters will be located at Room 728, Old South Building, Boston, where delegates may secure any information or have mail or other matter sent them. The Convention hall will be announced at the same time the hours for meeting and sessions are announced.

HOTELS.

The Committee on Hotels will make such reservation as is requested, and full details concerning hotel accommodations may be had by application to Mr. J. H. Griffin, Jr., 728 Old South Building, Boston, Mass.

TRANSPORTATION.

The members can either take the matter of transportation up individually or with their local secretary, bearing in mind, however, that they will be entitled to reduced rates of fare, announced for Boston's Old Home Week, in circular which has already been sent them.

WORK OF THE CONVENTION.

The Committee on Papers is arranging a strong program of papers from leading representatives of the various interests which the membership of our Society includes. The reading and discussion of these papers will constitute the solid work of the Convention. Besides this, the Committee on Exhibits is arranging for an interesting exhibition of illumination appliances and measuring apparatus. The notable examples of decorative il-

lumination which will be seen in the streets of Boston, will, by themselves, be worthy of the study of the members of this Society.

The Mayor of Boston will address the opening session of the Convention.

ENTERTAINMENT.

While it is planned to have a business Convention, the matter of entertainment for members, their ladies and guests, will be specially provided for, quite apart from the splendid opportunities for amusement afforded by Old Home Week festivities. The latter include military, civic and trade parades, illuminations, electrical pageants, and general opportunities for enjoyment that Boston offers to the "Stranger within her gates."

So many historic and scenic charms of Boston make it pre-eminently the best convention city in this country, especially for a midsummer convention.

CO-OPERATION.

It is hoped that each member of the Society will make a strenuous effort to be present, bringing his wife and friends. Do not fail to remember the benefit which you will get from hearing the authors read their own papers, from hearing the discussions on these papers, and from coming into intimate personal contact with your fellow members and co-workers, becoming acquainted with others in your field of activity and discussing various problems with them. All these benefits can never be derived from merely reading the transactions. The exhibits themselves will be of educational value from the fact that a large display of the various instruments used for illumination measurement and for other practical purposes has already been provided for, and a unique way of describing the methods of using these appliances has been devised. You should consider also the duty which you owe to the Society to make our first Convention successful and notable. There is nothing which will so redound to the credit of the Society and which will so increase its standing and its membership as a rousing good Convention. Please arrange to attend and arouse the interest of your friends and associates in so doing.

It has been voted by the Council that all prospective members whose applications for membership have been properly endorsed shall be entitled to all the privileges of the Society other than voting, holding office, or receiving transactions, until their application has been acted upon. Ask your local secretary for application blanks and see to it, that we add to our membership.

The Convention Chairman will deem it a personal favor if each member will, at the earliest possible moment, signify his intention to attend the Convention. Detail information will be forwarded to members later. Further advance information may either be obtained from local secretaries or by application to the Chairman of the Convention.

COMMITTEE ON ARRANGEMENTS.

J. S. Codman, Boston; C. L. Edgar, Boston; W. H. Atkins, Boston; E. N. Wrightington, Boston; T. H. Piser, Boston; A. T. Sampson, Boston; G. C. Keech, Chicago; J. R. Cravath, Chicago; C. W. Ridinger, Pittsburg; J. C. McQuiston, Pittsburg; I. H. Francis, Jr., Philadelphia; W. Forstall, Philadelphia; A. E. Forstall, New York; Preston Millar, New York.

COMMITTEE ON HOTELS.

J. S. Codman, Chairman; J. H. Griffin, Jr.

COMMITTEE ON PAPERS.

Dr. Louis Bell, Boston; J. S. Codman, J. C. McQuiston, Waldo S. Kellogg, J. R. Cravath, W. Forstall, Preston S. Millar.

SPECIAL COMMITTEE ON EDITING AND PUBLICATION.

W. Hand Browne, Jr., Dr. A. E. Kennelly, Dr. Louis Bell.

COMMITTEE ON EXHIBITS.

Prof. G. C. Shaad, Dr. Louis Bell, Preston S. Millar, V. R. Lansingh, J. S. Codman.

Reception Committee to be announced later.

Very respectfully,

JOHN CAMPBELL,

Chairman Convention Committee.

Meeting of the New York Section, April 12

TOPICAL DISCUSSION.

At a meeting of the New York Section, held April 12, a topical discussion took place on several questions. These and the discussions are given below.

I. *"To what extent in practice can the distribution of light about a lamp be modified by reflectors or globes?"*

V. R. Lansingh addressed the meeting on this subject and about fifty lantern slides were shown, giving the distribution of the open gas flame, the mantle burner, the gas arc and the incandescent electric lamp, as well as typical examples of redistribution of light by means of different globes and reflectors. The slides exhibited showed the distribution of light as given by globes and reflectors made of glass, metal, porcelain, mirror and other articles.

The following communication from Major E. L. Zalinski was read by L. J. Lewinson:

This distribution of light may be somewhat modified by varying the shapes and the materials of which the reflectors are made.

This will be illustrated by measurements obtained with reflectors having different variants, both as to shape and material. It is frequently assumed that all modifications of the distribution of light which may be desired can be obtained by variations of the shapes of reflectors; but experience has shown this to be so only to a limited extent. The greatest variation can best be secured, practically, by the combination of the effects produced by the modification of the shape of the reflector and the introduction of a material which will secure diffusion.

In order to make clear the distinction between diffusion and reflection of light, I quote the distinction given by Professor William Hallock, of the Department of Physics, Columbia University.

"I do not see how any one can contend that diffusion and regular reflection are

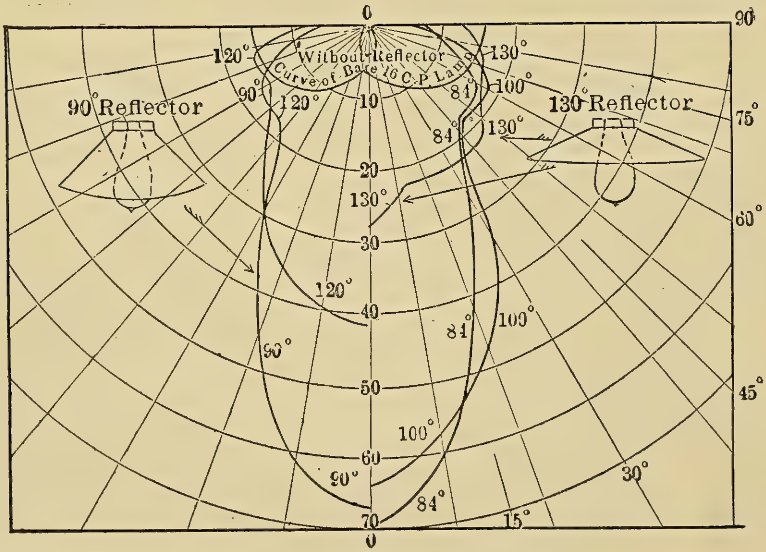


FIG. I.

the same phenomenon. Of course one may say that they are both due to difference in the optical properties of two media. Nevertheless, it is generally understood that by reflection we mean the case where the majority of the light is sent off at an angle equal to that of the incident light, and all in one direction. Scientifically stated, it is the case where the light, on leaving the surface has no simple, well-defined wave front. In diffusion, the light leaving the surface goes off in directions bearing no relation to the direction of the incident light; in fact, in all directions in a general plane of incidence. In this case the light has no simple, well-defined wave front, but a complex multitude of little waves traveling in all directions and not uniting in one general wave."

In Fig. 1, we have exemplars of resulting polar curves of plain prismatic glass reflectors having apertures of opening of approximately 84 degrees, 90 degrees, 100 degrees, 120 degrees and 130 degrees, respectively. It is here seen that, apparently, the reflectors decrease in efficiency with the increase of aperture.

But an examination of Fig. 2 places a different aspect on these values. This plate shows the Rousseau curves derived from the polar curves shown on Fig. 1. The casual observer will, from an inspection of the polar curves, determine the 90 degree reflector to have the greatest value. The value of mean lower hemispherical candle-power computed from the Rousseau diagram are as follows:

130	degrees	aperture	— 19.0	candle-power		—	standard.
120	"	"	— 19.4	"	"	—	102 per cent.
100	"	"	— 20.9	"	"	—	110 " "
90	"	"	— 18.8	"	"	—	99 " "
84	"	"	— 18.4	"	"	—	97 " "

Thus it is seen that the 100 degree aperture reflector gives twelve per cent. better results than the reflector with 130 degrees aperture. This also illustrates the errors which the layman is likely to fall into if his judgment is solely dependent on the apparent values as given by polar curves, and the advisability of the measured values of Rousseau curves being taken into full consideration.

From the preceding investigations the conclusion was arrived at that the distribution might be made better by coating the prismed-glass reflector with white porcelain, enamel, or other light-diffusing material, retaining at the same time a considerable portion of the directly downward intensity of light. Such coating would also tend to reduce the injurious and disagreeable glare of the clear glass reflectors, and better satisfy æsthetic and artistic requirements. Finally, the enamel used could be sufficiently translucent to prevent dark spots above the reflectors.

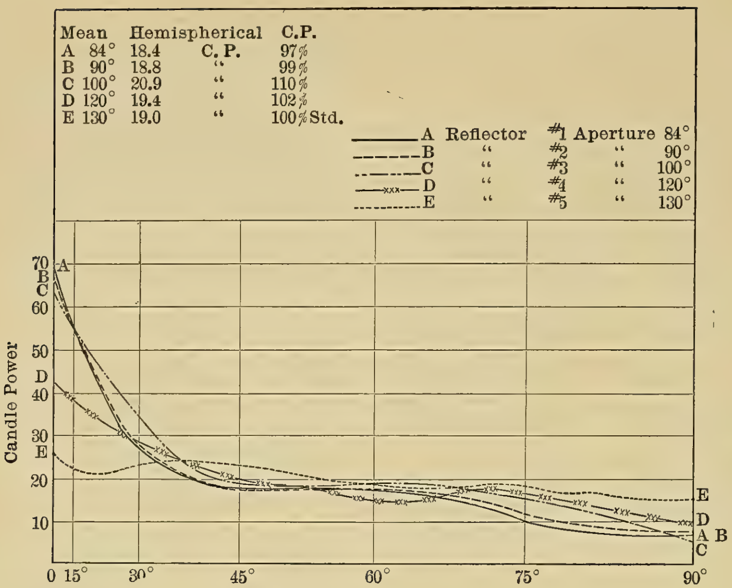
The advantages of the addition of diffusion to reflection is shown in Fig. 3. In this plate we secure, by a coating of white enamel or a detached covering of white glass, such as opal, a decidedly broader distribution of the light than obtainable by mere modifications of the shapes of prismatic glass reflectors. In this case better results are obtained by the use of an opal white glass shade placed over the clear prismatic glass reflector than by the direct application of the enamel coating to the prismed glass.

Fig. 4 shows results obtainable by a white enamel coating directly on the prismed glass, and the variations secured by sand blasting the interior surface of the glass reflector, securing a higher efficiency of the combined reflection and breadth of distribution of the light.

This shows a decided initial gain on the part of the sand blasted reflector. But in view of the fact that a lamp having a frosted bulb loses six per cent. of its efficiency within one month and very much more in a long lapse of time, due to the accretions of dust and dirt on the frosted surface, it would appear that a reflector having a sand-blasted or frosted interior surface would very rapidly lose in efficiency for like reason, and therefore has little practical value.

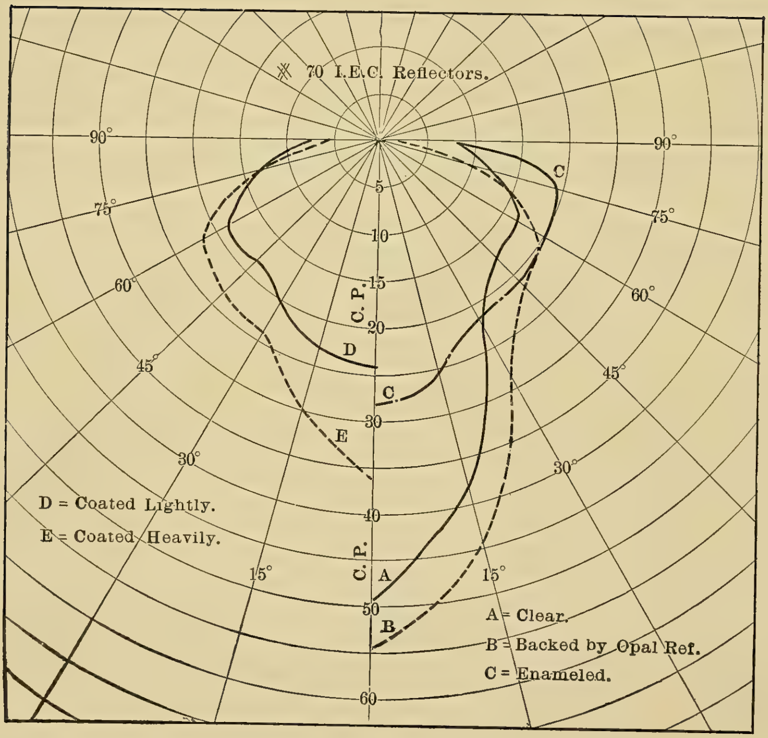
Fig. 5 shows the differences in distribution of light between a plain prismed glass reflector and a reflector of the same type coated with white enamel. While the plain prismed glass gives very high values at and near 0 degree, the enameled reflector gives the higher and maintains values further on. This secures a more uniform distribution of light, avoiding very bright spots while lowering the variations as between the maximum and minimum illumination. This serves materially to increase distinctness of vision.

An examination of this plate leads to the following points of interest, indicating



Mean Hemispherical C.P.
A 84° 18.4 C. P. 97%
B 90° 18.8 " 99%
C 100° 20.9 " 110%
D 120° 19.4 " 102%
E 130° 19.0 " 100% Std.
A Reflector #1 Aperture 84°
B " #2 " 90°
C " #3 " 100°
D " #4 " 120°
E " #5 " 130°
Candle Power
0 15° 30° 45° 60° 75° 90°

FIG. 2.



70 I.E.C. Reflectors.
C. P.
D = Coated Lightly.
E = Coated Heavily.
A = Clear.
B = Backed by Opal Ref.
C = Enameled.

FIG. 3.

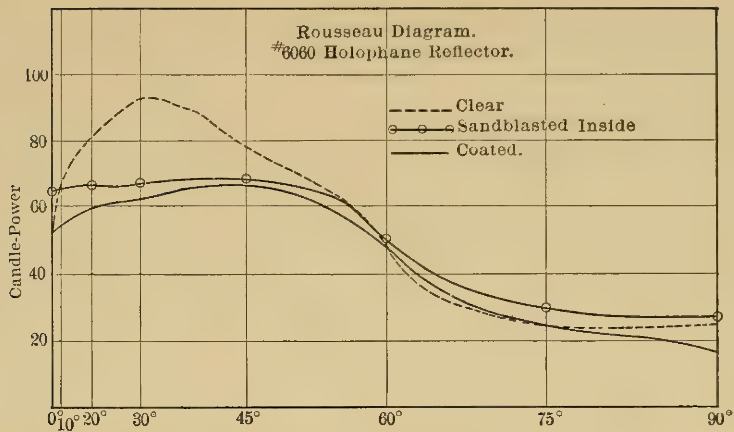


FIG. 4.

more uniform and advantageous illumination:

First, the ratio of maximum candle-power to minimum candle-power in the case of the diffusing reflector being taken as one in the ratio of maximum to minimum in the case of the clear glass reflector is found to be 1.6.

Second, the diffusing reflectors have their highest points of efficiency at about 45 degrees instead of 0 degrees as in the plain prismed glass.

These comments are based on data of photometric measurements made by the Electrical Testing Laboratories of New York City.

Dr. Louis Bell.—There is a good bit of misapprehension regarding the nature of the actual performance of reflectors, diffusing and otherwise. If you stop to look at a reflector of ordinary prismatic glass and watch it carefully to see where the light comes from, it at once appears that the distribution is gained by the traveling around of the bright area, to a very large extent. If you have a bowl with a bright filament, you get direct light in certain directions from the filament and you do get a lot of reflected light which is turned back into that direction. The reflection downward is comparatively slight for a short distance, and then from the side you get total reflection, which is the most effective kind of reflection, and get there-

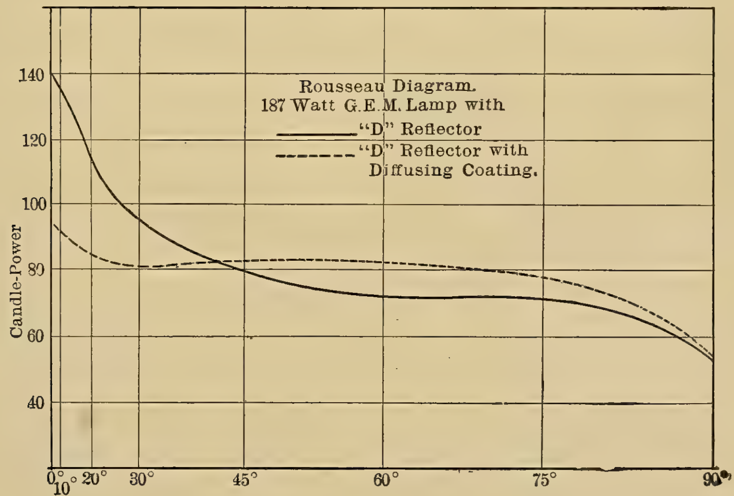


FIG. 5.

fore a strong zonal effect; but if you have a perfectly straight-sided reflector you get more or less light on these principles, and you also get the effect of a focal concentration of the light, upon which is superimposed the direct light. So in any form of reflector, where total reflection is the chief source of added efficiency, and it is a very great source of added efficiency to have such reflection, the light comes first from the lamp and second from the total reflection taking place in various ways. You generally find in the same position, away from the reflector, a strong beam from the lamp itself, and a strong beam which, as you stand under the reflector, you see comes from a powerful reflecting surface. This is most marked in the concentrated reflectors, which give a beam like the beam of a searchlight, very powerful and concentrated. In that case you find a quite marked local effect, some of the light is direct from the lamp, but if you put up the axis nearly to the horizontal and move away, you will reach a point where the inside of the big reflector gives a strong and uniform light. I tried one big reflector for concentrated effects, about nine and a half inches in diameter, which at a distance of perhaps 60 feet gives the effect of a great flaming disc. Thus by properly shaping the prisms and the reflector itself, you can give an enormous range of variations to the distribution. Now, what happens with any reflector, of whatever material it may be made, when you begin to make its surface a diffusing surface, is a thing concerning which there has been a great deal of misapprehension. The theoretical difference between diffused reflection and regular reflection, was very neatly given in the quotation in Major Zalinski's discussion, but this must be remembered, that from a practical standpoint you may have both diffused and regular reflection from the same surface. Any surface gives a general, rather than a directed distribution of light in so far as the surface is a diffusing one, and in point of fact—it is a thing which is generally misunderstood—you can take a prismatic glass reflector and gradually proceed to confer upon the outside or inside a matte surface, by sand blasting or etching process. At the first stage you will see that the outside is merely covered with the thinnest possible film. The diffusion is almost nil, the glass acting almost as before; a little bit more etching or sand blasting and you begin to get from the surface of the glass a diffusive effect which is superimposed upon the effect of the clear regular reflection, and that goes on and on increasing until you get a diffusing surface sufficiently dense, so that you can convert the effect into a pure diffused reflection; in other words, the progress from diffusion to pure prismatic reflection or pure mirror reflection is one which is not a sudden change in character in the least. The two kinds of reflection can exist in any degree superimposed upon each other, and in point of fact, as you can readily see, you may start with a reflector which gives almost a searchlight effect, and if you superimpose on that, by any process (it makes comparatively little difference what it is), a diffusing surface, you must inevitably, by virtue of the diffusion, instead of getting a ray thrown downward, get a ray thrown outward at all angles; at all events, all the diffused light is scattered, not absolutely uniformly, but with a very wide departure from regularity.

The consequence is that in every case when you pass from a pure reflecting surface to a pure diffusing surface, you are widening gradually the distribution of the lamp, because a certain amount of light which was concentrated before, now ceases to be concentrated and is scattered, and if you take a reflector and superimpose upon it diffusion, the tendency will always be to more and more uniform distribution, through lessening the sharp peaks downward, with a downward reflector, or cutting off the wings in an outward reflector.

The value of diffusion in the way of reducing sources of high intrinsic brilliancy is very great, but the point I want to impress is that the phenomena, diffusing and regular reflection, can and do customarily exist together and that every time you begin to diffuse light from the surface you begin to widen the distribution. If you start with a very strongly concentrating reflector and put on a light diffusing surface, the tendency will be to make it less strongly concentrated and converted more and more into a rounder distribution. If you start with a widely diffusing shade, at the beginning the change will still be toward uniformity, but will not be as marked as it is when you start with a strong downward beam. Some curves of composite reflection by Mr. Trotter were published a few weeks ago, which covered a range of experiments from zero incidence to nearly 90 degrees, and from 45 degrees, which happened to be the point at which regular reflection would take place, there was produced a very marked peak. The surface

concerned was ordinary bristol board. A nearly pure matte surface will give a change of intensity of, with respect to angle, something like that, and a really glossy surface, porcelain, will give very sharp regular reflection superimposed on the diffused reflector and you get all the grades between. Peaks mean that there is a strong amount of regular reflection tnere from substances like paper or porcelain, and the existence of such reflection on the pages of a printed book printed on highly calendared paper is one of the very troublesome things from the standpoint of hygiene. Many modern books, illustrated in half-tones, are printed on paper which presents just that combination of diffused and regular reflection, which throws a comparatively powerful beam, by reflection, into the eyes and causes the individual no end of trouble.

The two phenomena, diffused and regular reflection, then, often co-exist. If there is any kind of diffusing surface, the diffused reflection is simply superimposed upon the other. As the diffusion is more and more prominent, and the regular reflection less and less prominent, you will get a softening of these sharp peaks due to regular reflection, into a comparatively regular curve. The phenomenon passes from one phase to the other with entire uniformity and in every case where we use reflectors you will see if there is any diffusing surface, the effect of the light concentrated in this way passing down to a widening distribution and at the same time softening. It is the softening effect such as you find on a diffusing piece of paper which is the valuable thing sought in the diffusing reflector.

In passing, I may say that once in a while you strike a surface where the reflection is very irregular, where there is a certain amount of diffusion, and there is also a regular reflection on the plain surface, but with the regular reflection asymmetrical. For instance, light along any given direction may be diffused, while that along a direction precisely opposite may be almost purely reflected. As an ordinary thing, not only do regular reflection and the diffused reflection co-exist, but it is not at all necessary even that the regular reflection should be symmetrical.

E. Y. Porter.—Mr. Lansingh and others have brought out the difference between the photometric curve from any source and the Rousseau diagram showing that the former may be very misleading when applied to lamps with reflectors, all of which tends to show that we, as illuminating engineers, should be more interested in the results of the actual illumination on the floor, or whatever surface is to be illuminated, than in the candle-power or even the photometric efficiency, if I may so speak, of the light source. That, of course, takes in the matter of distribution and all that. While I do not imagine it is all new, yet I think there is a term which is not being used as much as its importance warrants, which we might call the "illuminating efficiency" of any system of lighting. We are very familiar with the term "watts per square foot," but that tells us nothing as to illuminating effect; it does not give any true indication of the light we get. We also use the term "mean candle feet," or "mean flux," as representing the illumination. Neither does that tell us anything from an economical standpoint, but if we can combine these two, and get what we might call the "illuminating efficiency," which could be applied to any system of illumination in a given space, then we would get something which tells us what its value is from an economic standpoint. I may represent this illuminating efficiency, as I call it, as the mean foot-candles multiplied by the square feet and divided by the watts, or briefly, the illumination divided by the watts per square foot. That is something very definite. If the illuminating engineer can go to a client and measure his illumination under one system of lighting, and then can alter that system of lighting and increase the value of the lighting efficiency from one to two, he is earning a good commission. That is just the thing we are after, getting the very highest illuminating efficiency out of any system or combination of units. That brings us to the difference between illuminating efficiency and what you may call the photometric efficiency. I have recently made measurements between two systems of lighting where the illuminating efficiency was very different from the comparative photometric efficiency. We run across that very frequently. Moreover, I believe we are on the verge of being able to determine these things very readily. Through the courtesy of one of our triends at Harrison, I have been privileged to use an illuminometer, which is not on the market yet, I understand, but which my experience leads me to believe will be of immense value to illuminating engineers generally. It is simple, self-contained and very portable. I am sure it has been to me a source of great information in being able easily

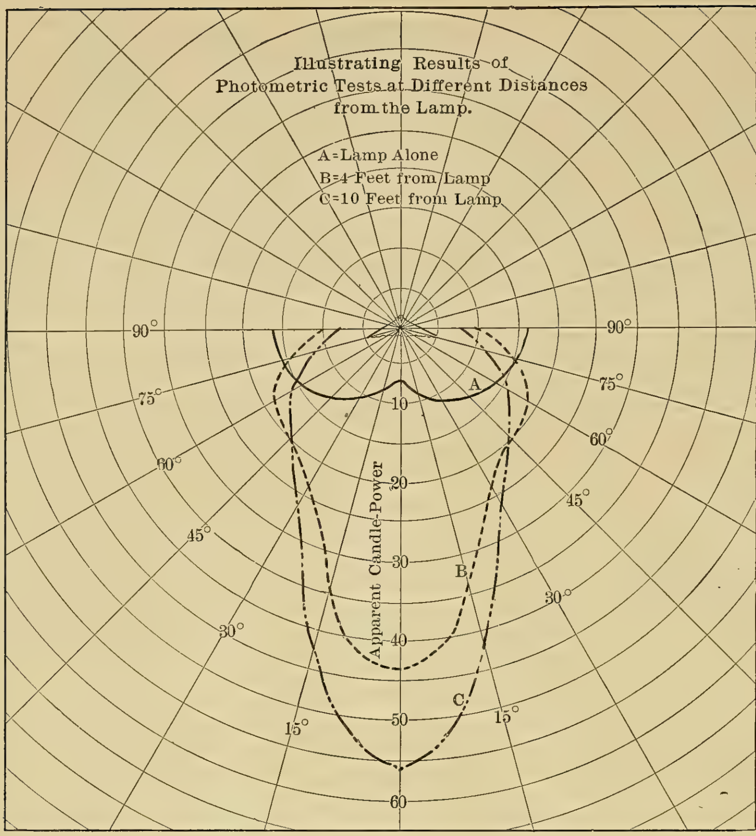


FIG. 6.

to get a concrete conception of what we have in the matter of illumination, and I hope and believe that eventually the distributing companies will be selling illumination instead of watts. It is not at all inconceivable that a little selenium device could be arranged which could be placed in various parts of the room and would register the actual illumination delivered.

P. S. Millar.—For a determination of the extent to which the distribution of light may be modified by the use of globes and reflectors, we must look to photometric tests. One feature of photometric tests where reflectors are used is well illustrated upon the accompanying diagram (Fig. 6), showing photometric curves throughout the lower hemisphere about a sixteen candle-power lamp used alone and with a prismatic reflector. The continuous line curve represents results obtained at a distance of ten feet from the lamp. The broken line curve represents the results of similar tests made at four feet from the lamp. This is a good illustration of the failure of the law of inverse squares to hold good when a source of light is equipped with a light directing auxiliary. Since results of such photometric tests at relatively short distances cannot be depended upon to yield true candle-power values, some other means of expression must be adopted. All purposes would seem to be satisfactorily served by designating the values to be apparent candle-power as observed at a specified distance. The diagram also illustrates the necessity of making determinations at a fixed and stated distance from the light source, since if measurements are made with a traveling photometer where photometric balances are obtained at various distances, much confusion in interpretation of results may arise.

The next diagram (Fig. 7) is rather reassuring in that it shows that the discoloration of bulbs of sixteen candle-power carbon filament lamps throughout life does not have material effect upon the loss of light occasioned by the use of a six-inch frosted globe. The loss due to the use of

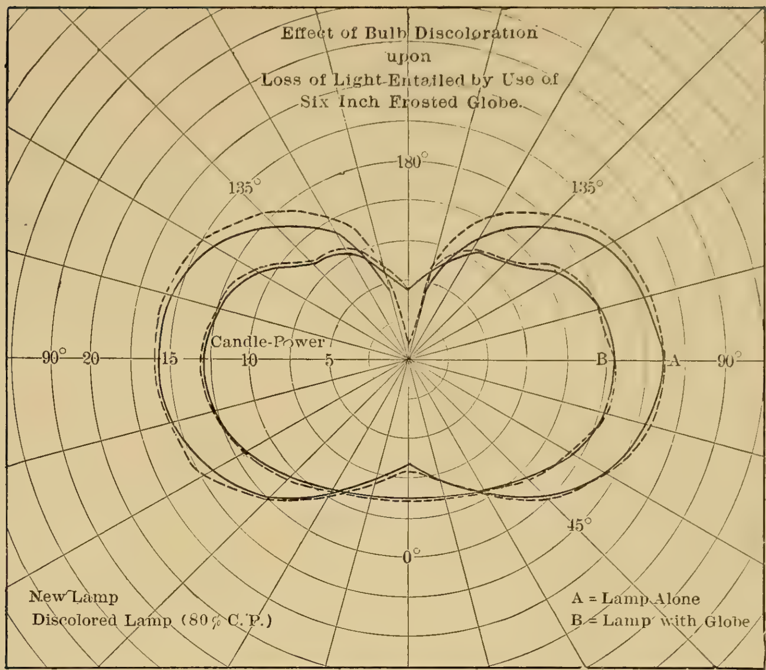

Effect of Bulb Discoloration
upon
Loss of Light Entailed by Use of
Six Inch Frosted Globe.
180°
135°
135°
Candle-Power
90°
20
15
10
5
B
A
90°
45°
0°
New Lamp
Discolored Lamp (80% C.P.)
A = Lamp Alone
B = Lamp with Globe

FIG. 7.

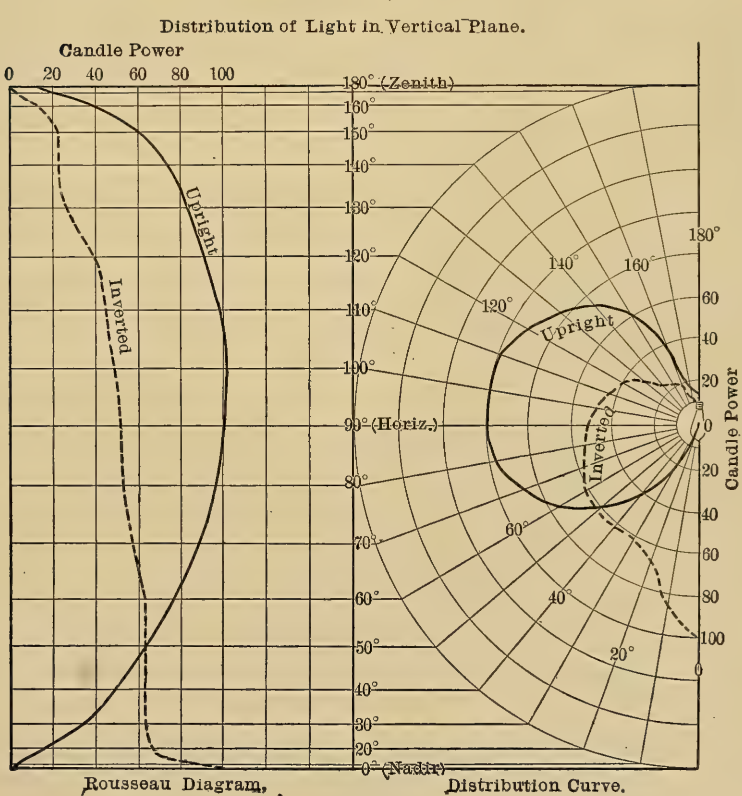

Distribution of Light in Vertical Plane.
Candle Power
0 20 40 60 80 100
180° (Zenith)
160°
150°
140°
130°
120°
110°
100°
90° (Horiz.)
80°
70°
60°
50°
40°
30°
20°
0° (Nadir)
Upright
Inverted
180°
140°
160°
120°
Upright
Inverted
60°
40°
20°
60
40
20
0
20
40
60
80
100
0
Candle Power
Rousseau Diagram,
Distribution Curve.

FIG. 8.

the globe with a new and an old carbon filament lamp differs by not more than one per cent.

2. "*Comparative Rating of Inverted and Upright Gas Lamps.*"

P. S. Millar.—The necessity for arriving at some satisfactory means of rating gas lamps is illustrated in the accompanying diagram (Fig. 8), which represents results of photometric tests upon an upright incandescent gas lamp and an inverted incandescent gas lamp equipped with a spherical frosted globe having a small hole at the bottom. Some of the photometric values are as follows:

Candle-Power.	Upright.	Inverted.
Mean horizontal	100	50
Nadir	1	100
Mean spherical	76	47
Mean lower hemispherical	69	60

Notwithstanding that the upright lamp has an illuminating power considerably greater than the inverted lamp and under conditions of most intelligent use probably 50 per cent. greater than the inverted lamp, yet it would not be at all surprising to find both lamps rated as 100 candle-power lamps. While there is probably no one method of rating illuminants which would be entirely fair to all illuminants or even to all gas lamps, yet there would seem to be at the present time no method which would in the long run be more satisfactory and fair to all types than that of basing all comparisons upon the mean spherical candle-power value.

The Chair (*E. L. Elliott*).—In regard to the upright and inverted burners, I think the point Mr. Millar brought out of the proper method of commercial rating of these lamps is most interesting. The practice of rating lamps by their horizontal intensity is undoubtedly the result of illuminating gas practice, and was good as long as the lamps naturally gave out their maximum intensity horizontally; but in the evolution which has taken place in lamps, both electric and gas lamps have come into use which give their maximum intensity vertically, and as a consequence, comparativey little horizontally. What are you going to do about rating them? The manufacturer of electric lamps has escaped, by rating his lamps by watts; but the gas man has not that convenient means of escape. The beauty of rating in watts is that the layman knows nothing at all as to what it means. If you were to use the exactly analogous rating for a gas lamp and say that it burns so many feet of gas per hour, the layman understands your terms, and the whole thing is given away. The whole question of the rating of light sources in view of the radical changes and improvements which have taken place in the last few years, both in what may be termed the more ordinary forms of incandescent electric lights and incandescent gas lights and the decidedly new departures in electric lamps such as the mercury vapor and vacuum tubes, has revealed a condition in which the old method of rating is absolutely meaningless. I have regretted to see a tendency on the part of manufacturers to befog the matter by trying to escape in a mist of watts and other subterfuges, instead of squarely meeting the issue, and getting at some more rational method. I have no doubt that the committee that has been appointed by the Illuminating Engineering Society to consider the matter of standards will do good work in clearing this up.

C. A. Barton.—Nothing has been said about the æsthetic side of the reflector problem, which I appreciate very much. I had dinner this evening in one of the leading hotels in the city, and was particularly pleased at the effect from the prismatic glass reflector, but the point Mr. Millar just brought up about the direct rays from the source of illumination appealed to me forcibly, because I recently took up that very subject of reflected light from reflecting surfaces with one of the concerns in the city who have been in the business for many years and have great difficulty with the atmospheric dust on all reflecting surfaces. It resolved itself into a question of maintenance, which I do not want to discuss here, but the diagram of the gas lamp shown by Mr. Millar (Fig. 8), which gave the distribution of light from the direct source of the light, by the vertical burner and the inverted burner, seem to me to serve as very good illustrations in discussing this question of the use of reflectors. It seems to me that from the point of illumination that the room or the area lighted by the inverted gas lamp has a very much more pleasing illumination than that from the vertical gas burner, no matter what shade you use. It has been my observation that the illumination is more pleasing from an inverted mantle than from a vertical gas burner.

3. "*Standards of Lighting, Primary and Secondary.*"

J. E. Woodwell.—May I call attention to a bulletin entitled "A Comparison of the Units of Luminous Intensity of the United States with those of Germany, England

and France," by Richard P. Hyde, of the Bureau of Standards in Washington, which bears directly on the subject at hand, and which will be issued shortly? Dr. Hyde took abroad with him a number of incandescent lamps, carefully standardized at the Bureau of Standards, and left these at the laboratories in England, Germany and France, there to be carefully checked up with the foreign standards; and as he traveled from laboratory to laboratory, they were rechecked in the different laboratories and showed a remarkably close agreement on the part of the different observers, working with different apparatus. The establishment of primary and secondary standards of light is fundamental to illuminating engineering. In connection with the establishment of primary standards, considerable research work has already been done for the last four or five years, but much more remains to be done. The Bureau of Standards has planned to take up this work seriously with a view to investigating all of the present standards and experimenting with others which may occur to them as desirable variations of the present types.

It might be well to call attention to the distinction between a standard and a unit of candle-power. It is not essential that we arrive at once at an absolute standard. We are getting along very well with other physical standards which may not be absolutely correct. The meter, the standard of length, is not what it was originally intended to be, though it approximates it, and in the same way with other standards which have been established in the effort to secure a definite relation in the correlation of physical units, it has been necessary, in practice, to depart somewhat from that ideal. A unit of light can at least be tentatively established which will serve as a basis for comparison with any standard or other unit which may eventually be accepted by the different countries.

4. *"Is it Ever Desirable to Mix Colors of Light by Different Kinds of Illuminants in Store Lighting?"*

E. L. Elliott.—While the New York Post Office is not exactly a store, it certainly is an example of polychromatic lighting. It would be interesting to have some discussion on it. I presume most of you have noticed the various lamps which are in use there; the flaming arcs, mercury arcs, incandescents, Moore tubes, Nernst lamps and ordinary arcs. What sort of an effect would such lighting have in a department store?

W. H. Gardiner.—I cannot conceive of conditions which would make it desirable to mix different colors of light or different kinds of illuminants in a store. Speaking from experience, however, I have been almost tempted to say that, in the majority of stores I have seen, different kinds of illuminants seem to be preferred. I think that condition comes about through two reasons: First, let us say that the illuminating installation has been put in distinctly by laymen with the idea of getting different sizes of units in different places, without direct attention to the quality of the light produced or the mixing qualities of the different lights. The next reason is that a great many commercial installations are matters of growth. A man will put in a lot of arc lamps, and then he wants to light some corners, and will put in some incandescent lamps about the edge of the room, or *vice versa,* and in that way we get mixtures. It seems to me, from the way I look at it, the answer to the question is "No." The problem is to determine that quality of light which is desirable for each location; next that quantity of light which is practical or financially most desirable, and then put it in throughout the store and have the illumination standard and uniform in each location. In that way you can get more desirable results, as far as the lights are concerned and from an æsthetic point of view.

E. Y. Porter.—Speaking of department stores, it has come to my notice in connection with the Moore tube, in a department store in Newark, where, on account of color effects it was desirable to use the white of daylight color in one part of a certain floor, and adjacent to it is the yellow Moore tube. Naturally the contrast is quite marked between the yellow light and the pure white light. It simply accentuates the colors of both, it makes the yellow light look red and it makes the white light look blue, just as when you have daylight and incandescent light mixing. In this particular case it seemed desirable to make both of the same color.

PROCEEDINGS

Papers Read Before Technical Societies

DISCUSSION

Report of Committee to Consider Specifications for Street Lighting

Read before the National Electric Light Association.

In the year 1894 a committee of experts, appointed by the association to consider the rating of arc lamps, reported at the seventeenth convention, then in session at Washington, a preamble and resolution which was adopted as follows:

"Recognizing the difficulty, if not impossibility, of measuring with any degree of accuracy the illuminating power of the arc lamp, and the great necessity for a more precise definition and statement of the obligations of the producer of electricity for illuminating purposes to the consumer thereof, be it

"*Resolved,* That in the opinion of this convention what is ordinarily known as a 2,000-c.p. arc lamp is one requiring on the average 450 watts for its maintenance, the measurements being made at the lamp terminals, where no sensible resistance is included in series with the arc. In case such resistance is used, it must be excluded in the measurement of the voltage."

The rating of arc lamps on the basis of energy consumed, as set forth in the resolution, was then and would now be satisfactory as an equitable means of determining either a proper rate of charge or illuminating value for street arc lighting furnished by a company to a municipality, under the same conditions, but at the time of the adoption of this resolution there was in use in the United States no type of arc lamp other than the open arc, which, although of many makes and designs, gave approximately the same illuminating power for a given amount of energy. Wherever the rating adopted by the committee in 1894 has been employed in connection with open-arc lamps of the general type then in use, little or no difficulty has been experienced in the adjustment of differences arising from interpretations of contracts.

During the very year in which this rating was adopted, however, the commercial introduction of enclosed-arc lamps began, and within the past ten or twelve years the gradual displacement of open-arc by enclosed-arc lamps has taken place. The manufacture of open-arc lamps has practically ceased as a result of their inability to compete with the enclosed type, and manufacturers have devoted themselves almost exclusively to the latter unit quite recently. During the past four or five years there have been placed upon the market a number of distinct new types of lamps, which have been known by the general designation of "flaming carbon" or "luminous arc" lamps, some of which originated from American ideas, while others were imported.

The characteristics of the various lamps mentioned, taken either individually or grouped in classes, are so widely at variance in performance in the ratio between light produced and energy expended that the difficulties experienced by operating companies are greater now than they were in 1894, and the preamble then adopted is equally applicable to-day by reason of the introduction of these new devices.

In addition to the new types of arc lamps, there have also been placed on the market and are now offered for sale certain kinds of mercury-vapor or vacuum-tube lamps, which can be used for street lighting, as well as a considerable number of new incandescent lamps constructed of some form of metallized filament. Quite a number of the latter are already in use, with every prospect of their general introduction within a reasonable time.

Any attempt to compare the illuminating value of these latest forms of lamps, which are or may be used for street lighting, on

the basis of energy consumed, is not only futile, but would be ruinous to the contracting company, for while the so-called high-efficiency lamps operate on a lesser expenditure of energy, they also give a larger volume of light. No reason can be given why a contractor should be penalized for giving more light than contracted for, after having made considerable investment for that purpose, simply because the number of watts consumed is less, notwithstanding that other items of expense and renewals may be considerably increased.

Your committee, after a most careful consideration of the difficulties to be met and for the purpose of establishing a definite basis, assumed: That, inasmuch as the lighting of streets by contract is a matter of *illumination produced* rather than of *apparatus employed*, the terms used in specifications should be in terms of illumination and not of energy consumed; that the individual lamp of each class should be the unit of number charged for; and that the average illuminating power of each unit should be comparable with and have a value equal to a known standard at proper relative distance.

The following report is submitted as the best provisional solution of the problem of street lamp specification that the unsatisfactory existing state of the science and art of outdoor photometry permits.

The committee considers that street-lighting lamps should not be rated in candle-power under contract specifications; because unless qualified as to the space distribution of the candle-power, such rating may be entirely misleading. The lamp may, by suitable reflectors, be made to possess a large candle-power in some particular direction or zone, and yet be very ineffective as a practical street illuminant. Consequently, the committee considers that the rating of street lamps in contract specifications should be in terms of the mean normal illumination cast at a considerable distance from the lamp, along the street which it illumines, *i. e.*, the mean illumination thrown by the lamp upon a plane surface at a considerable distance from the lamp and supported perpendicularly to the rays.

The following specifications are drawn to cover the ordinary conditions of street lighting, and are recommended to replace previous specifications, such as those appearing in the *Report of the Committee on Rating of Arc Lamps* of the National Electric Light Association at the meeting of 1894, a copy of which is reported above:

(1) Under ordinary conditions of street arc lighting, with lamps spaced 200 to 600 feet apart, specifications for street lamps should define the mean illumination thrown by the individual lamp, in position in the street, as measured at the height of the observer's eye and perpendicular to the rays, at some point not less than 200 feet nor more than 300 feet distant, along a level street, from a position immediately below the lamp, with all extraneous light screened off and with no reflection from surrounding objects not forming part of the lamp equipment.*

(2) When using smaller units of light, such as series incandescent lamps spaced shorter distances apart, a correspondingly shorter distance from the lamp could be chosen in measuring the illumination.

(3) The lamp contracted for should give a mean normal illumination at the test point (selected as in Sections 1 and 2) not less than the illumination given by the stationary standard incandescent lamp of 16 candle-power at 1/x of the distance. The said standard incandescent lamp should be a standardized seasoned lamp having a determined candle-power in a fixed direction.

(4) When the lamp tested fluctuates in intensity, a number of observations of the maximum normal illumination should be made at a distance of not less than 200 feet horizontally from beneath the lamp, and the average of these measurements should be taken as the average maximum

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* The reason for leaving the horizontal distance flexible along the street within the range between 200 and 300 feet, is that a definitely specified distance such as 250 feet might be unsuitable for the purpose of the measurement.

Within the horizontal distance in excess of 200 feet, the distance correction for the height of the lamp above the observer's eye is ordinarily unimportant.

* (a) When a reading-distance instrument is used for measuring the mean normal illumination at specified horizontal range, the average of a number of maximum distances at which a certain size of print can be distinguished may be called the average maximum distance, and the average of a similar number of minimum distances the average minimum distance. From these, the mean distance at which an illumination is cast normally, sufficient for distinguishing that size of print can be determined. This mean distance must lie within the 200-300 feet horizontal range specified in Section 1. In most cases the arithmetical mean of the average maximum and average minimum distances may be taken as the said mean distance with an accuracy sufficient for practical purposes. The illumination needed for distinguishing the size of print may be determined for each particular observer from measurements of the reading distance with the standard incandescent lamp referred to in Section 3.

(b) When a portable photometer is used at a fixed horizontal distance, such as 250 feet, the mean normal illumination of a fluctuating lamp may be obtained by taking the average of not less than 50 observations at intervals of not less than one-half minute.

illumination. A similar number of observations of the minimum normal illumination should be made, the average of which should be taken as the average minimum illumination. The arithmetical mean of the said average maximum and minimum illuminations should be taken as the mean normal illumination called for in Section 1.*

(5) A reasonable number of lamps covered by the contract should be tested.

(6) For measuring the mean normal illumination of a lamp, comparison with the standard incandescent lamp may be made either with a suitable portable photometer or with a reading distance instrument, such as the so-called "luminometer."

(7) The unobstructed mean normal illumination must not be less at shorter distances than at the point of test.

(8) An approximate list of the mean normal illuminations thrown by street lamps of standard manufacture, at horizontal distances within the 200-300-foot range, hung approximately 20 feet above the level of the observer's eye, is given in the following table:

Data from which table is to be prepared are not yet completed. Table will be furnished later.

Your committee during the consideration of this subject invited to its meetings and sought the advice and assistance of a number of the most prominent illuminating engineers and arc lamp experts, and in that connection hereby expresses its appreciation for services rendered by Dr. Clayton H. Sharpe, Mr. Caryl D. Haskins, Mr. Frank Conrad, Mr. Carl Hering, Mr. Louis B. Marks and L. D. Howard Gilmour, and especially to Mr. W. D'A. Ryan for the quantity of data furnished to the committee for its use and the large amount of labor performed in the collection of additional data required in the preparation of the schedules.

Respectfully submitted,

Dudley Farrand, Chairman.
A. E. Kennelly,
Charles P. Steinmetz,
Louis A. Ferguson,
Paul Spencer.
Committee.

Indefinite Candle-Power in Municipal Contracts

By E. L. Elliott.

Read before the National Electric Light Association.

It is doubtful if there is any legal instrument that is a more fertile source of litigation than a contract. Even the most studied and painstaking work of minds highly trained in the technology of law is never proof against misunderstanding, misconstruction, and loopholes for evasion. The inherent weakness of a contract is a direct result of the difficulty of two different minds making themselves mutually understood. The phrasing of a contract is an attempt to express a "meeting of minds," and in the final test its true meaning can be determined only by a careful consideration of all the circumstances that tend to show the actual basis upon which the two minds met. While it is absolutely impossible to guard against differences of opinion as to the meaning of a contract, the very existence of such a difficulty furnishes an urgent reason for the most explicit statements and rigorous exactitude in the use of terms. This applies particularly to terms that are used with a special or technical meaning.

There are in existence what are popularly supposed to be lighting contracts, involving the payment of many millions of dollars annually, which if carefully scrutinized will be found not to be lighting contracts at all in the strict sense of the term, but contracts for the sale of electric current in connection with the use of certain apparatus for generating light by means of the current furnished. It may be broadly stated that light has never been sold as a commodity; that is, the payments made have never been based upon a measurement of the actual quantity of light furnished. This is a result of the simple fact that, up to the present time, there has been no means of measuring light with sufficient accuracy to make such a basis of payment possible. Light, being a form of energy, can be measured as a commodity only by taking it in connection with the measurement of time; and an instrument for integrating luminous flux with time has, so far as we are aware, never been even attempted, much less perfected. All light sources fluctuate in the quantity of light given out, and this fluctuation has been one of the chief obstacles in reducing pho-

tometry to an exact science. Of the various commercial light-sources, the electric arc is notoriously the most variable; hence the difficulties in expressing its light-giving power by any constant quantity. All attempts that have been made involve a method of averages but entirely neglect the element of time; and if an arc varies between, say, 100 and 400 spherical candle-power, it by no means follows that the average flux of light throughout the period is the arithmetical mean of these quantities. It may give out light at the maximum power for three-fourths of the time, and at the minimum for only one-fourth, or *vice versa,* or in any other ratio.

In view of these inherent obstacles in the measurement of light, and especially from the electric arc, it is not surprising that many so-called lighting contracts exist in which the amount of light to be furnished is a wholly indeterminate quantity; and it is somewhat surprising that such contracts have not given rise to more litigation than they have. When the arc lamp first made its appearance it wholly baffled the attempts of photometrists, with the means then at their disposal, in their attempts to give it a candle-power rating that should give even an approximate idea of its actual light-giving power. It is related that when one of the first commercial arc lamps was completed it was examined by a college professor, who was asked to give an estimate of its candle-power. He replied in an offhand manner that he thought it would run about 2,000; and an arc lamp of that particular type has been called a 2,000-c.p. lamp even unto this day. Although it was soon learned that such a rating was enormously exaggerated, the fiction, having once come into use, persisted to such an extent as to find its way into many lighting contracts. In order to prevent the term being accepted at its face value by the uninitiated, a committee of this association took the matter in hand and gave a specification for lamps of so-called "nominal," or "standard 2,000 candle-power." While this committee represented only one party to lighting contracts, the definition that it formulated has been generally respected as an avenue of escape from the difficulties of the situation. Where the lamp thus described was maintained in contracts calling for a 2,000-c.p. arc light, the acceptance of the definition served to prevent legal controversies; but in the progress of the art of lighting the particular form of lamps that was officially rated as 2,000 candle-power has become almost extinct; and when the newer forms of lamps were substituted for the older form, the term "2,000-c.p. arc light" lost the only fixed and definite meaning that it had ever possessed.

This was the condition of affairs that recently brought about a very thorough sifting of the subject of candle-power rating with relation to contract obligations in the city of Colorado Springs. Briefly stated, the controversy arose as follows: a contract for street lighting was drawn in 1898, which called for the use of "arc lamps of standard 2,000 candle-power." The old form of open-arc lamp, which had been made to father this rating by the committee before mentioned, was used for a certain length of time without objection by the city. With the advent of the enclosed-arc lamp, however, the system was changed, and series alternating enclosed lamps were installed in the streets. These furnished the street illumination for something over a year without protest on the part of either the citizens or public officials, when, through the exigencies of politics, or from a suddenly awakened zeal on the part of certain public officials to protect the rights of the citizens (the conditions are sometimes strangely coincident), it was discovered that the lamps in use did not give 2,000 candle-power, but somewhere near 300 candle-power instead, and a claim was made for a proportional rebate in the lighting bills already paid. The controversy was finally settled according to the most approved modern methods; namely, by reference to a board of arbitrators.

In the hearing of the case it is probable that the question of candle-power in particular, and the operation of an arc lamp in general, was more minutely threshed out by the most prominent experts in the country than ever before in the history of electric lighting. The testimony ran the whole gamut, from the frank admission of aldermen that they had not the slightest idea what candle-power meant, and cared less, to a stereopticon demonstration by a college professor of the difference between the formation of the alternating and the direct-current arcs.

Incidentally, it may be of interest to state that, at the hearing of his case, the profession of illuminating engineering was proclaimed officially for the first time; two of the expert witnesses, in qualifying, gave their profession as that of illuminating engineer. It may also be stated here that had the services of such a professional illuminating engineer been secured by either of

the parties to the controversies, if for no other purpose than to assist in drawing the contract, or to advise on the change of lamps made, the whole litigation, with its attendant expenses and annoyances, would have been avoided.

The first contention of the city was that the contract called for 2,000-c.p. lamps, and that therefore the lamps furnished should give actually 2,000 candle-power; this contention being ruthlessly swept away by the experts for both sides, who unhesitatingly stated that the term was only a popular fiction and referred, if to anything, to a particular type of lamp rather than to candle-power. Having been routed from the first line of defense, it fell back upon the difference in cande-power between the old open-arc lamp and the particular kind of enclosed-arc lamp that had been substituted. This defense proved to be impregnable, and an award was made to cover the deficiency. As the arbitrators unanimously agreed that there was no evidence of any attempt to defraud, or of bad faith on either side, the whole controversy was the result of indefinite and misleading statements in the contract.

As before stated, it was testified by some of the aldermen that they had no idea of what the term "candle-power" meant, and were only anxious "to secure the best light possible at the lowest rate." On general principles, they were fulfilling their whole duty as representatives of the citizens. Using the term "city" to signify the citizens, and not any one or more of the city officials, the city really had no particular interest in the term "candle-power." It supposed it was buying and receiving a certain illumination of its streets, and in judging of this illumination candle-power had no place. It was simply a question of what illumination made the streets most serviceable at night.

Generally speaking, the lighting of streets has two purposes: first, to facilitate traffic; and second, to prevent the commission of crimes. In the smaller towns and cities the first is by far the more important object. So far, then, as the city is concerned the only question at issue is a very practical one, which requires no expert or technical knowledge, but judgment based upon mere "horse sense." In judging of two different systems of street illumination, the question of candle-power, voltage, watts, and the rest of the strange tribe of queer-sounding names, is of no consequence whatever from the citizen's point of view. The single thing to be decided is, by which system of illumination is traffic in the streets most facilitated? To be sure, the illuminating engineer knows that this judgment depends upon intensity of illumination, size of the actual or apparent source, intrinsic brilliancy, and various other technical considerations. While the citizen does not know the various elements making up good illumination, he is quite as competent to judge of the actual result as the most erudite expert.

The use of the single term candle-power as a basis for lighting contracts is therefore objectionable from any point of view. To the citizen it either conveys no meaning at all, or is assumed to refer to the degree and effectiveness of the illumination of the streets, which is very far from the truth. To the party furnishing the light it may refer to a certain type of lamp, or to intensity in a specified direction, or to the total flux of light, or to the lower hemispherical flux. The use of a term in a contract upon which payments are to be based, which even to those familiar with the technology of the subject may have any one of a half-dozen meanings, and to the layman either no meaning at all or a meaning apart from any of those understood by the engineer, is manifestly opposed to the requisite of definiteness which should be the first aim in the wording of all contracts. Beyond doubt there is no term having any pretense to scientific accuracy that is capable of so many different constructions, and is so loosely used, as this term candle-power; and until some competent authority has given it a fixed meaning, and this meaning has become reasonably familiar to those dealing with the subject, the only safe way is either to omit it altogether from the phraseology of legal documents or carefully and rigidly define the particular sense in which it is used in each case.

In view of the controversies that have arisen from the unjustified and careless use of the 2,000-c.p. rating for arc lamps, and the self-evident need of greater accuracy in the terms used to designate the performances of light-sources, it is astonishing to find a present tendency on the part of manufacturers to still further befog the situation. Compared with the commercial rating of an incandescent electric lamp by its wattage, the designation of an arc lamp of a particular type as a 2,000-c.p. light is definite and sane. Furthermore, the 2,000-c.p. fiction had the excuse of having originated innocently, which is more than can be said of the watt-rating fallacy.

The advantages of smaller units for street lighting in the uniformity of illumination produced are indisputable. This fact, in connection with the equally indisputable fact that incandescent lamps of far higher efficiency than the carbon filament type are destined soon to become commercially practical, must have a wide influence in the near future on methods of electric street-lighting contracts of the near future. The designation of such lamps by their wattage alone is unfair alike to the consumer and producer, and is therefore inevitably bound to become a source of contention and dissatisfaction is persisted in. The satisfied customer is the one who receives what he pays for, *judged from his point of view.* The citizen buys light, not for the sake of the light itself, but for the illumination that it produces. When the aldermen in Colorado Springs directed their efforts solely to obtaining all the light that they could for the money, they were doing exactly right from their point of view; by "light" they mean "illumination"; and so long as they got better illumination, or, as they would have expressed it, more light, for a given sum, or at a less rate than before, they were quite satisfied to let the producing company have whatever advantages might be obtained from any improvements in the ways and means of producing illumination.

What, then, is to be substituted for this generally discredited and ambiguous term "candle-power"? In the present state of the art of illuminating engineering the answer to this question is simple; the foot-candle as a unit for measuring illumination is a strictly definite term without possibility of misconstruction or ambiguity. The single objection to the use of this term as a basis of lighting contracts heretofore has been the want of practical means of measuring illumination; but happily this condition no longer exists. There are at the present time three or four instruments for measuring illumination which compare very favorably with the most approved instruments for measuring intensity of light or "candle-power." It only remains, then, to specify the direction in which the illumination is to be measured; that is, either on a horizontal or a vertical plane, or on a plane perpendicular to the principal rays at the point measured. The measurement of illumination is something which the layman of ordinary intelligence can quickly comprehend, and the matter therefore of determining whether or not a contract is being carried out is capable of direct verification by the citizen or official without the indirect method of referring the matter to an expert; and expert testimony in legal controversies is notoriously unsatisfactory. The expert on illumination should be used like tne doctor or lawyer—to prevent trouble rather than cure it.

The lessons to be learned from the Colorado Springs controversy in regard to the drawing of lighting contracts are:

If the term "candle-power" is to be used at all, its exact meaning as used in the particular contract should be carefully defined.

Illumination, measured in foot-candles, is a more scientific, exact and generally satisfactory basis for a contract than light.

The watt consumption of a lamp should never be used as a measure of its light-giving power.

Every lighting contract should be examined and approved by a competent illuminating engineer.

Indefinite Obligations in Municipal Contracts

By Henry Floy.

Read before the National Electric Light Association.

The most explicit and perfectly-drawn contract does not necessarily insure its fulfilment by the parties thereto. A contract that is indefinite in its terms will probably result in confusion and controversy or possibly something worse. If, in addition to indefiniteness in terms, the subject of a contract is not thoroughly understood or the product to be furnished is difficult of definition, as in the case of light, for which there is yet no international primary standard, the wording of a contract may be almost farcical, making the literal performance impossible. While a contract should be as perfectly drawn as practicable it should be considered but little more than a memorandum of understanding, because its value depends very largely upon the good will and good faith of its makers. The good will of the public is almost essential to a public-service corporation if it is to earn continuous dividends. Too often, however, the good feeling between the parties making a contract leads to a looseness in wording or indefiniteness in meaning that is afterwards the cause of controversy or disagreement when the contract is interpreted under other conditions or by successors in interest. The time at which to secure a clear and definite contract is at its making.

With good will and good faith, so necessary to the proper carrying out of a contract, both parties thereto should definitely understand its obligations. The cause of controversy and bad feeling between corporations and municipalities will usually be found to be:

Either a lax appreciation by the corporations of their full obligations to the municipalities, or

An indefinite understanding by the municipalities of the obligations undertaken by the corporations.

A lax appreciation of their obligations has in the past caused many corporations, believing themselves secure in the monopolistic control of the public utilities, to be indifferent to public opinion, with the result that all the companies are now beginning to reap the whirlwind in regulation of their rates and activities, by commissions or legislatures. Some companies—I do not say all—have aroused public hostility because of their failure to treat the public honestly and fairly. I need only mention the adjusting of electrical apparatus to supply less than normal current, the reduction of candle-power of gas during periods when detection was impossible or improbable, as well-known illustrations of the practices to which I refer.

Recently in discussing the many public-utility bills now being considered by various State legislatures, an engineer, in reply to my statement that the commissions must be so constituted as to insure a "square deal" between the public and the corporations, said, "the corporations do not want a square deal, as far as they are concerned." While in some instances this has been the attitude of public-service corporations, it is not at present the spirit of the majority of such corporations, but until it is abandoned by all, some are bound to suffer through overwrought public opinion.

Aside from contract obligations there are moral obligations that the corporations have been slow to recognize. The prevalent feeling that unless a lamp is extinguished it should be paid for, regardless of the light it gives, is wrong and will not be allowed to continue. The too common practice of attempting to compel acceptance of, say, a 450-watt alternating-current lamp for a direct-current lamp of the same wattage shows gross ignorance or wilful misrepresentation and the award in the Colorado Springs Case has forever, I hope, obliterated from the minds of the engineering profession the thought that wattage is a measure of light.

To intelligently fulfil its contract, a corporation should keep full station records that will show the energy supplied a municipality, which records might well be open to the public as an evidence of good faith. Such records materially strengthened the Colorado Springs company's case and were eventually made the basis of award in deciding the deficiency in service claimed. A station should also ascertain from time to time its loss, leakage, and so forth; but the careful adjustment of lamps, the use of proper carbons and globes, and strict attention to all such details are equally essential, because it must be remembered that light and not kilowatt-output is the real measure of fulfilment of a lighting contract.

With regard to the municipalities' understanding the obligations assumed by the corporations, they have not usually heretofore attempted to understand them, but recently they have learned that a contract for lighting may say one thing but mean another, and the result is often hard feeling, controversy and useless expense, a condition of affairs for which this association is largely responsible. It is certainly astonishing that this association has allowed a definition, adopted for one type of lamp and insufficiently exact for that, to stand for thirteen years practically unchallenged and absolutely unchanged, although the art has meanwhile been revolutionized and the definition remains only as an anachronism to befog and confuse the minds of representatives of both corporations and municipalities, causing needless controversy and financial waste. It must be admitted, however, that all the responsibility for misunderstanding between the corporations and municipalities does not lie with the former; too often the representatives of municipalities endeavor to draw contracts without proper engineering advice, with the natural result that the contracts are vague, indefinite, or they provide something contrary to what is really intended. In order to avoid this condition of affairs it may be necessary at the start for the corporations to agree to pay for the services of a consulting illuminating engineer, to be selected by and detained in the employ of the city. The results secured through the creation of good feeling and confidence between the two parties to a clear and definite contract will probably more than compensate for the expense involved.

Having awakened to the knowledge of its rights, the public is demanding more than ever before of the corporations and is

insisting that the latter give the full value of their undertakings. So fas as I know, the Colorado Springs case established the precedent that if a lighting company is not giving the quantity of light called for in the contract the city may recover financial damage, and hereafter there is little likelihood that the cities will accept as satisfactory and pay full price for lamps that are merely burning, without regard to the light that they should normally provide.

The greatly-aroused interest in the question of lighting and illumination that has developed during the past year or two can not but result in the making of more exact and intelligent contracts for lighting, and your association is to be congratulated in having had a committee at work on this matter, which is now prepared to submit definite recommendations.

In making definitions and endeavoring to draw up a set of specifications for street lighting, as proposed by this association, it behooves us to be particularly careful to approach the matter with unbiased minds. It must be remembered that the association is naturally interested in one side of the proposition, and any dogmas it may set forth are likely to be received as prejudiced and biased, so that especial pains must be taken to insure that any unprejudiced person will agree that the definitions we have made or the specifications we have drawn are fair to both parties interested in their use.

In conclusion, a company entering into a contract with a municipality should work along the following lines:

First—Have a clear understanding with the party to the contract, as to exactly what the contract is to cover.

Second—See that the wording of the contract is exact, with a tendency toward repetition and too full explanation rather than brevity and omission.

Third—Maintain good feeling and confidence throughout the life of the contract, even at the sacrifice of some profit.

Fourth—Keep station records of daily output, including line loss, leakage, and so forth (but remember it is light, not wattage, that is being sold), so that at any time you are prepared to go into court or before arbitrators and prove your case; but such procedure is not to be followed except as a last resource.

New Developments in Arc Lamps and High Efficiency Electrodes

By George M. Little.

Read before the National Electric Light Association.

Arcs for lighting may be formed between electrodes of many different kinds. This paper deals with the development of the so-called magnetite electrodes and of a lamp suitable for burning them. A few points of comparison between these metallic-oxide electrodes and carbon electrodes will be considered, and some of the many interesting advantages possessed by the metallic oxide electrodes and lamp will be touched on. Among these are the long life, high efficiency and good distribution and color of light.

The magnetite electrodes were so named because magnetite is usually one of the constituents of the negative or cathode, but it would be more satisfactory to call them *metallic-oxide* electrodes, as in addition to the magnetite there are always at least two other oxides present, namely, oxide of titanium and oxide of chromium.

These electrodes are made in a very different manner from the carbon electrodes. As is well known, the latter are squirted or modeled from a plastic mixture and are baked; the carbon furnishing sufficient mechanical strength and electrical conductivity. A metallic-oxide electrode cannot be made this way, for it is a familiar fact that a fine powder is a poor conductor, no matter of what it is composed, and as these electrodes are made for the most part from finely powdered oxides, it is evident that a conducting binder or a conducting case would have to be used. In practice, the mixture of oxides is tamped into a thin iron tube and the end sealed in an arc.

The oxides have distinct and separate reasons for their presence. The titanium oxide has the property of rendering the arc luminous; and it may be here noted that the metallic-oxide arc is a flame arc, the light not coming from a crater as with carbons. The oxide of iron gives conductivity to the fused mixture when cold, the other oxides being conductors only when hot. The oxide of chromium prevents a too-rapid consumption, so that by its use an electrode may be given a very long life.

The positive, or anode, used with these metallic-oxide negatives is generally a metal and is consumed much more slowly than the negative. This is contrary to what

would be expected, judging by the action of carbon electrodes.

There are a number of advantages possessed by the metallic arc over the carbon arc. In the first place, the efficiency is much better; that is, a metallic arc lamp operating on a 4-ampere current with approximately 65 to 70 volts at the arc will give a light equal or superior to that of a 6.6-ampere, 75-volt, direct-current, enclosed-carbon arc lamp.

The distribution of light is far better. This is owing to the fact that in the enclosed-carbon arc practically all the light comes from the crater on the flat under-surface of the upper electrode, most of it being thrown down and not serving to illuminate the street between lamps. The light from the carbon arc itself is weak and of a blue color. This is very pronounced at times, especially if the flat under-surface of the upper electrode is somewhat inclined, thus hiding the crater. In the case of the metallic-oxide electrodes, the arc is itself the source of light, practically none coming from the crater, except by reflection. The metallic arc is much like a candle flame, having its luminous and non-luminous zones. The light is brightest near that end of the arc which is next to the negative electrode, and comes from a hollow cone-shaped mantle of volatilized oxide of titanium rendered incandescent by the heat of the arc, just as in the candle flame the light comes from a hollow cone-shaped mantle of carbon particles made white-hot by the heat of the flame.

The voltage required to maintain a metallic arc is less than that of an enclosed-carbon arc. It is a familiar fact that an enclosed-carbon lamp will not burn properly with the arc voltage down to 65, while a metallic arc will burn well at less than 55. Metallic arcs are adjusted to burn at from 65 volts to 75 volts in different cases, while the carbon arcs are all set at 80. This is a very evident advantage in favor of the metallic arc, as more lamps may be put on a circuit without raising the voltage on the line.

The life of carbon electrodes, as a rule, is not over 150 hours, while the metallic-oxide electrodes can go considerably longer.

The uniform white color of the metallic arc is in marked contrast to the changeable blue and white of the enclosed-carbon arc.

As the metallic-oxide electrodes are not burned "enclosed," there is no inner globe required on the lamp.

While it looked easy to secure all of these advantages, many difficulties appeared, but they have now practically all been overcome. In the first experiments the electrodes were trimmed with the anode or positive above and the negative or metallic-oxide electrode below, just as carbon lamps are trimmed, but a number of troubles presented themselves.

First—The bright portion of the arc was near the surface of the lower electrode, which cast a large shadow.

Second—The light reflected from the brilliant surface of the fused slag on the lower electrode was thrown upward and could only be partly saved by using a reflector.

Third—An under-feed mechanism was seen to be necessary, as, contrary to the action of carbon electrodes, the negative metallic-oxide electrode is the more rapidly consumed.

Fourth—Only a comparatively short metallic-oxide electrode could be used, as a long one would necessitate the use of an unwieldy long glass globe. This would limit the life and could only be met by adopting a negative electrode of large diameter, which it is evident would be undesirable.

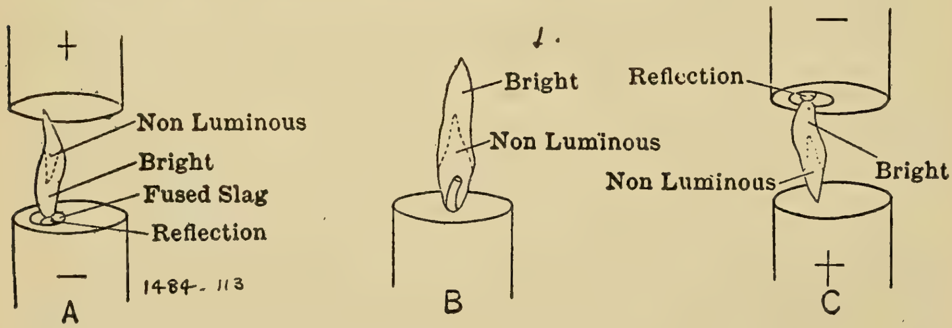


FIG. 1. A—Metallic arc with negative below.
B—Candle flame.
C—Metallic arc with negative above.

Fifth—A particularly undesirable feature was the gathering of a large amount of reddish soot that would collect in spongy masses around the electrodes, obscuring the light. This had to be removed by some mechanical means, such as scraping or shaking it off, and some receptacle other than the glass globe had to be provided to catch it.

Sixth—The negative or metallic electrode was seen to burn to a blunt taper point, causing the arc to be very unsteady, as it tended to leave the end and run up the side in the manner of the carbon arc when flaming.

As noted above, the bright portion of the metallic arc is located near the surface of the negative electrode, and it was seen to be very desirable to burn the electrodes with the negative above, thus getting the bright portion of the arc in such a position that the shadow thrown down would be less, and that the light reflected from the brilliant surface of the fused pool of slag on the negative electrode would be thrown down and utilized instead of being thrown upward and wasted. The other advantages, noted above, possessed by the carbon lamp would be retained if this inverted position of the electrodes could be made practical.

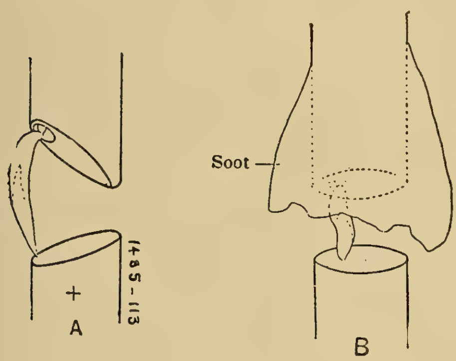


FIG. 2.

A—SHOWING HOW THE ENDS OF CARBONS WASTED AWAY TO A BEVEL BEFORE USING THE DOWN-DRAFT OF AIR.

B—SHOWING ACCUMULATION OF SPONGE-LIKE MASSES OF SOOT BEFORE USING THE DOWN-DRAFT OF AIR.

IT FROM TOUCHING OR DEPOSIT-

The first attempt to burn the metallic-oxide electrode above and the metallic electrode below showed that there were serious obstacles to be overcome before it could become a practical method. In the first place, the electrode would not keep a square end, but would waste away on one side, and the arc would run up this bevel, or slope, giving a very unsteady light. In the second place, the volatilized oxides of iron, chromium, titanium, and so forth, would condense on the sides of the electrodes and hang down as a fringe or curtain, hiding the light.

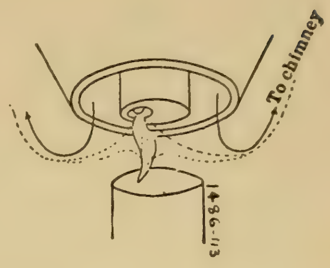


FIG. 3.—THE DOWN-DRAFT OF AIR FORCES THE SOOT TO TAKE THE PATH SHOWN BY THE DOTTED LINE, EFFECTUALLY KEEPING IT FROM TOUCHING OR DEPOSITING ON ANYTHING.

The first means taken to overcome these troubles was the introduction of a rotating draft of air around the arc. This had the effect of forcing the arc to hold to a central position, stopped the crooked burning, and steadied the light, but did not take care of the fumes. Attempts to blow the fumes away sidewise gave only partial success. Finally, a current of air was directed down around the arc, and this gave excellent results. The electrode burned perfectly square, and the clean layer of air prevented any gathering of fumes. This was a very marked advance, as this did away with any need for a mechanical scraper or shaker, the soot practically all passing out of the chimney and not requiring to be caught in any receptacle, the globe remaining clean.

When burning metallic-oxide electrodes with the metallic-oxide stick below, copper was used as an anode with fair results. On reversing the position of the electrodes, it was found that the new conditions made it possible to improve on the action of a pure copper anode, and a number of changes were accordingly made. In the first place, if the arc plays for a time on pure copper, it will oxidize the surface. This oxide will fuse to a slag that becomes an insulator when cold, and on starting a cold lamp it is necessary to strike the electrodes together hard enough to break through the

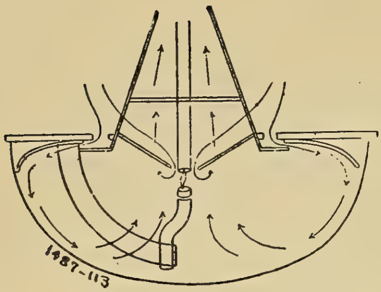


FIG. 4.—PATH TAKEN BY AIR CURRENTS IN LAMP.

slag. To strike such a hard blow is undesirable, as if it is done while the lamp is burning—for example, when feeding—it is liable to spatter the fused slag out on to the glass globe. A simple remedy for this consisted in using an anode containing metals or alloys whose oxides, when fused together, would make a slag that is a good conductor when cold. The steadiness of the light largely depends on the composition of the slag, its uniformity and temperature. The anode surface is at all times covered with this slag, which slowly dissolves the metal and is itself slowly volatilized. If the arc plays on bare metal it consumes it rapidly, and it was found desirable to secure this slag cover from being knocked off. This was accomplished by providing a rough surface for it to cling to, and by running the entire anode tip very hot.

A characteristic property of the metallic arc has been a very noticeable dying-down or dimming of the light, which would occur at irregular intervals, especially after the electrodes had burned for 20 hours or more. These dim spells would last from a few seconds to two or three minutes, when the normal brilliancy would return. This is explained as follows: In the metallic arc, the brilliancy is largely due to the presence of volatilized oxide of titanium, and anything that interferes with the uniform evolution of vapors of titanium will cause the light to dim—for example, the presence of a high percentage of highly infusible oxide of chromium. This oxide of chromium is volatilized at a slower rate than the oxides of titanium and iron, and after the electrode has been burning some 20 hours the slag on the end of the cathode has become very rich in oxide of chromium, which forms a film on the surface of the fused pool of oxides. When the film is not present there is a plentiful evolution of oxides of iron and titanium, and there is a bright arc. The oxide of chromium can be seen to gather on and finally entirely cover the surface of the pool. This stops the evaporation of titanium and iron, and the light turns to a bluish color and dies down until the chromium film is burned away again. This trouble was met by modifying the mixture in such a way that the oxide of chromium could not separate from the oxides of iron and titanium, thus doing away with the film on the surface and entirely doing away with the dim spells.

In carbon lamps, there was very little done to keep the impurities volatilized from the carbons from depositing on the globe. This trouble had to be met by the carbon manufacturers, who were prodded up to produce carbons containing less than 0.2 per cent. of impurities, but this means was not to be considered in the case of the metallic-arc lamp. The metallic-arc electrodes, being chiefly composed of oxides of iron, titanium and chromium, do not burn away to an invisible gas, as does a carbon stick, but are volatilized bodily, and the vapors instantly condense, on leaving the arc, to a fluffy reddish soot that settles on every-

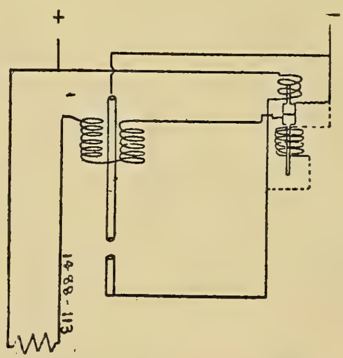


FIG. 5.—DIAGRAM OF CONNECTIONS.

thing it touches, so that a chimney is a very necessary feature in the lamp. This soot, if it comes in contact with the reflector or globe, will smudge them badly in ten minutes. As was noted before, a current of air flowing down around the electrode served admirably to keep it clean, so it was applied to the reflector and globe with gratifying results. A thin layer of air is introduced at the top of the reflector and forms a shield through which the soot-laden air cannot penetrate, so that the reflector and globe will keep clean for a long time.

As the air currents play such an import-

ant part in this lamp, it became necessary to do a large amount of experimental work on the design of an air intake and of a chimney top. The chimney could not be made long enough to cause a very powerful draft, so the wind was very apt to blow down it; but by persistent effort the openings have been so designed that the wind may blow from any direction (up, down or sidewise), and the only effect is to increase the natural draft in the lamp. Incidentally, the increasing of this draft actually centers the arc and holds it remarkably quiet.

It was found advisable to run the lamp at 4 amperes and 65 to 68 volts at the arc with a cutout set at 85. This low cutout was made possible by the inverted position of the electrodes and by the peculiar arrangement of the air draft, which prevented any tendency of the arc to flame or to run up the side of the electrode. Without these features, a cutout of 100 to 110 volts would be necessary. As the power factor at which the lamps operate depends largely on the amount of variation of voltage in the arc, this 85-volt cutout is seen to be very desirable. In actual service, the lamps, including a mercury arc rectifier, run very well at from 65 to 70 per cent. power-factor.

In several places above we have described special conditions that must be obtained for getting the best results with these electrodes, and these conditions, of course, must be supplied by the lamp in which they are burned. An example of a lamp well adapted for this service is here shown. A study of its design and construction will show that it is simple and rugged, as no float feet is used; it being necessary only to strike an arc and hold the electrode in a permanent position until, due to change in voltage, the cutout causes the restriking of the arc. The lamp consists essentially of a base and top, connected by a chimney, a set of magnets for striking the arc, a shunt cutout for causing the lamp to feed due to rise in voltage, and a series cutout for disconnecting the striking magnets after the arc has been formed.

The special conditions described with regard to drafts are obtained as seen here by the down-draft tube, which directs the current of air down around the electrode, another current of air over the reflector and circling around the globe forming a means of protection to them, and a special construction of top and case for giving proper draft conditions when under all conditions of wind.

The Frequencies of Flicker at which Variations in Illumination Vanish

By A. E. Kennelly and S. E. Whiting.

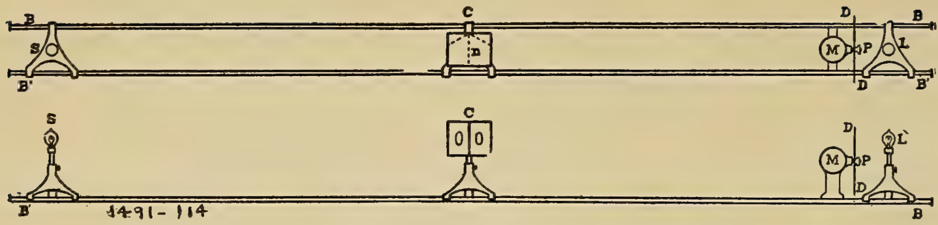
Read before the National Electric Light Association.

It is well known that arc lamps operating on 60-cycle alternating-current circuits and subject, therefore, to 120 cycles of flicker per second, produce visible flickering of illumination on moving targets. It is also well known that arc lamps operating on 25-cycle alternating-current circuits produce visible flickering of illumination on stationary targets, and that incandescent lamps operating on such circuits also produce visible flickering in illumination under certain conditions. There is, however, considerable difference of opinion as to the conditions under which flickering appears or disappears in the illumination cast by incandescent lamps operating on low-frequency alternating-current circuits. It is the object of this paper to describe some experiments made by the writers on this matter, and the results thereby indicated.

The measurements were made in a photometer-room with dark walls, by employing a rotating sector disc immediately in front of a steady and stationary incandescent lamp, thus producing an artificial flicker in its light. It is known that when different observers attempt to balance, in the ordinary photometer, a steady illumination against a flickering illumination, they make different estimates of the photometer setting.* The eye does not seem to be able to integrate or average an illumination that undergoes flickering, or visibly rapid cyclic variation. One observer may estimate the mean balance of illumination relatively high and another relatively low with respect to the mean value. It was found on trial, however, that when several different observers simultaneously watched a stationary target illuminated by a beam of light which was artificially flickered through the intervention of a rotating sector disc, they substantially agreed upon the speed of rotation at which the flickering disappeared. This method of observation was, therefore, adopted in the tests here described.

The general arrangement of the apparatus used is indicated in plan view by Figure 1 and in side elevation by Figure

* "Measurement of Mean Horizontal Candle-Power," by Hyde and Cady. Bulletin of Bureau of Standards, Vol. II. No. 3. 1907.



FIGS. 1 AND 2.—PLAN AND ELEVATION OF PHOTOMETER.

2. *BB, B'B'* are the parallel bars of a photometer track, *S* a standard incandescent lamp, *L* the lamp under test. The small direct-current motor *M* carries a pair of superposed sector-discs *DD* on its shaft. The photometer carriage *C* contains a circular white paper screen *n*, 3.6 centimeters (1.4 inches) in diameter with a central grease-spot 1.1 centimeters (0.43 inch) in diameter, viewed through a pair of inclined mirrors in the usual way. Figure 3 shows a sector disc with two 90-degree windows. The aperture of these windows could be reduced down to mere slits, at will, by mounting the two sector discs, side by side on the motor shaft and changing their relative phases. The screw clamp *P* enabled them to be clamped in any desired phase relation. As indicated in Figure 3, the window apertures are wide open. Each revolution of the disc *DD* will, therefore, produce two successive openings and closings of the sector shutters for equal periods of time, and two complete cycles of flicker. In Figure 4 the same motor is provided with a pair of discs with four 45-degree windows, with similar closing adjustments. Each revolution of the motor shaft will in this case produce four complete cycles of flicker.

The first step in each series of measurements was to measure the horizontal intensity of the lamp *L* selected, by finding a balance of illumination on the Bunsen screen *n*, in the usual way, with the disc at rest and the window open. The standard lamp *S* was then removed, and the voltage held steadily at the terminals of the test lamp *L*.

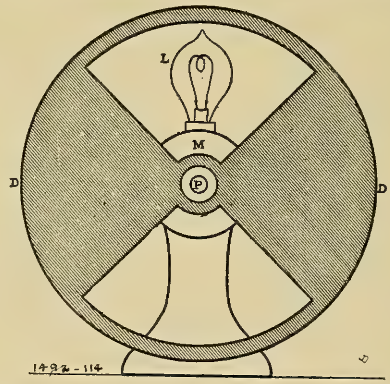


FIG. 3.—TWO-WINDOW SECTOR-DISC AND DRIVING MOTOR.

TABLE I

VANISHING-FLICKER SPEEDS AND FREQUENCIES, AT VARIOUS ILLUMINATIONS ON PHOTOMETER SCREEN, AS VIEWED DIRECTLY FROM A DISTANCE OF FIFTY CENTIMETERS.

1.	2.	3.	4.	5.
4.0	16.0	2.065	842	
			740	25.6
			720	
3.0	9.0	3.67	870	
			840	27.4
			760	
2.5	6.25	5.29	840	
			920	29.3
			880	
2.0	4.0	8.26	980	
			940	32.0
			960	
1.5	2.25	14.69	1090	
			1040	35.2
			1040	
1.0	1.0	33.04	1110	
			1100	36.8
			1100	
0.5	0.25	132.2	1290	
			1390	44.1
			1290	

Horizontal intensity of lamp *L*, candle-power, 33.04.
Col. 1.—Distance *D* between lamp *L* and screen *n*, meters.
Col. 2.—D^2 (meters)^2.
Col. 3.—Illumination on screen *n*, meter-candles.
Col. 4.—Speed of motor *M* at vanishing-flicker, r.p.m.
Col. 5.—Mean vanishing-flicker frequency, cycles per second.

In the first series of measurements, the carriage *C* was moved to the left-hand end of the track in Figure 1, at a distance of five meters from the lamp *L*, and the sector-disc *DD* set in rotation. By reducing the resistance in the circuit of the series motor *M*, its speed was steadily increased until the observer at the photometer carriage ceased

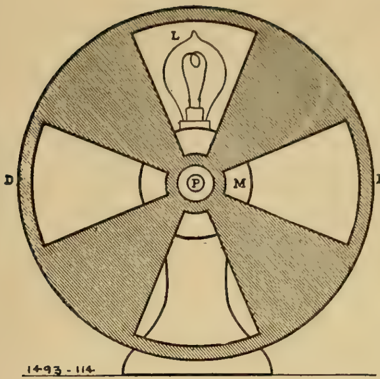


FIG. 4.—FOUR-WINDOW SECTOR-DISC AND DRIVING MOTOR.

to perceive a flicker, or estimated the illumination on the circular photometer screen *n* as steady. This observation was repeated with each of three observers in such a manner that each formed an independent estimate of the vanishing-flicker speed.

The results obtained in this set of observations are recorded in Table I, which may be taken as a fair sample of a series of measurements.

The maximum variation between the vanishing-flicker speeds as estimated by the three observers at any single illumination is found in Table I to be about 16 per cent.; while the average variation is 3.1 per cent. The series of mean vanishing-flicker frequencies is plotted in curve *A*, Figure 5, where the ordinates are mean frequencies of flicker, and the abscissæ are maximum cyclic illuminations on the target, expressed in meter-candles. Additional scales are indicated for reading these illuminations in foot-candles or in meter-hefners. One hefner is taken as 0.88 candle. Curve *A* shows that with low illuminations of less than 5 meter-candles, or, say, 0.5 foot-candle, the vanishing-flicker frequency increases rapidly, and approximately in proportion to the illumination. In the neighborhood of 5 meter-candles, the curve flattens rapidly, and beyond 10 meter-candles, or, say, 1 foot-candle, the vanishing-flicker frequency increases but slowly with increasing illumination.

On repeating the measurements with a stationary sheet of white paper 20.3 centimeters by 13.3 centimeters (8 inches by 5.25 inches) as a target, in place of the small white Bunsen carriage screen, supporting the target on the photometer bar perpendicularly to the beam of light passing through the sector-disc, and bringing the observer's eye to within a distance of about 35 centimeters (14 inches) from the center of the target, the rotation speeds and vanishing-flicker frequencies were found to be increased in the manner indicated by the curve *B*, Figure 5; so that with the illumination of 200 meter-candles (227.5 meter-hefners or 18.6 foot-candles) the frequency of flicker at which the illumination appeared to become steady was over 53 cycles per second.

The reason for the greater mean vanishing-flicker frequency with the larger white target is believed to be found in the increased surface area of retina undergoing flicker stimulation. For a given normal illumination on a target of a given color and reflective quality, on a dark background, situated at a given distance from the eye, the greater the area of the illuminated target, the greater will be the area of the target's image on the retina of the observer's eye. Consequently, when the illumination on the target flickers, the larger the target surface, the larger the retinal area over which the flicker stimulus is exerted.

A roughly circular patch on the retina of the eye, about 1.25 millimeters (0.05 inch) in diameter, called the *yellow spot*, and especially the central circular portion thereof, about 0.25 millimeter in diameter, called the *fovea centralis*, is said to possess the greatest sensitiveness of visual perception; so that in focusing objects on the retina for scrutiny, their images are brought on to this spot or region of the retina. It was noticed that the yellow spot was certainly not the only region of the retina sensitive to flicker, because occasionally the vanishing-flicker speed and frequency could be observed more sensitively by directing the eyes slightly aside from the target; so that the image of the target would be caused to fall on the retina off the *fovea*. Without having any measurements to indicate the retinal limits of flicker perception, it would seem from the observations that a large area of the retina possesses this sensitiveness in some degree. The total stimulus due to flicker can be increased for a given intensity of illumination on a small target, either by bringing the target nearer to the eye—at least within the focusing range, and limit of visual accommodation—or by increasing the area of the illuminated target, keeping its distance from the eye unchanged. Comparing, however, curves *A* and *B*, Figure 5, the stimulated

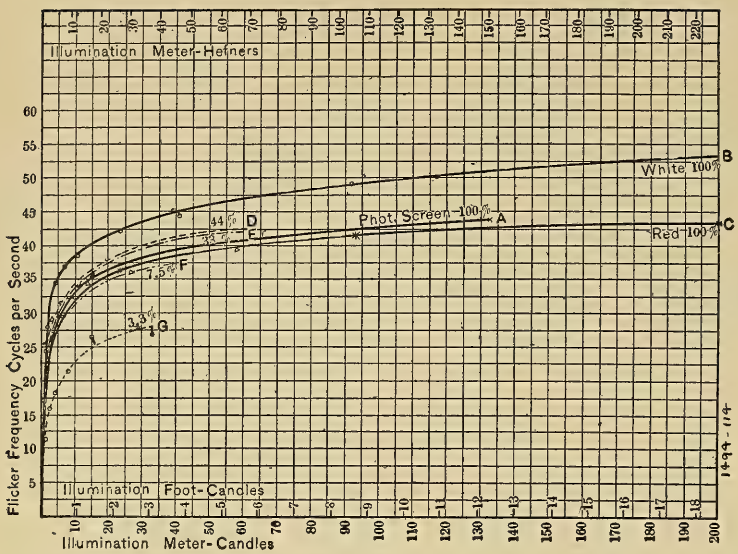


FIG. 5.—CURVES OF FREQUENCIES AT WHICH FLICKERING, IN DIFFERENT INTENSITIES OF ILLUMINATION, APPEARED TO VANISH.

retinal area in the case of curve *B* must have been about 25 times greater than in the case of curve *A;* but for illuminations above 10 meter-candles, the vanishing-flicker frequencies are only about 15 per cent. greater on the *B* curve than on the *A* curve. Consequently, although the total retinal stimulus appears to increase with the area of retinal surface to which flicker stimulus is applied, it does not increase in anything like the proportion of areas involved.

A screen of bright Turkey red color about 25 centimeters square (10 inches by 10 inches) was next used as a target, and the results obtained indicated on curve *C*, Figure 5. The vanishing-flicker frequencies were a little lower with the red target than with the small white target formed by the Bunsen photometer screen. In other words, the total retinal stimulus from a target exposed to a given illumination intensity but absorbing all the light except red, was markedly less than from a white target of smaller size, and slightly less than from the small white circular disc of paper in the Bunsen photometer carriage. Other colors of target were tried, with the general result that the lighter and brighter the color the higher the vanishing-flicker frequency. The darker and more somber the color of the target, viewed against a black background, the lower the vanishing-flicker frequencies.

No appreciable difference was found in the observed flicker frequencies whether the sector-disc had two windows, as in Figure 3, or four windows, as in Figure 4. In other words, the vanishing-flicker speed of rotation with the latter was half that with the former.

Considering the double-window sector-disc of Figure 3, it was found that whether the windows were opened to their full angular width of 90 degrees, or were nearly closed, the vanishing-flicker speeds and frequencies for given maximum cyclic illumination on the target were substantially the same. In the former case there would of course be equal successive intervals of light and shadow; while in the latter, there would be shorter intervals of light followed by longer intervals of shadow. The mean illumination would be proportional to the angular aperture of the window. Consequently, the vanishing-flicker frequency does not seem to depend upon the mean illumination of the target nor upon the shape of the wave of cyclic illumination, but only upon the maximum and minimum illumination; or the limits of illumination in each cycle. At frequencies above the vanishing-flicker frequency, or with steady apparent illumination, the latter was found to indicate the true average value in the photometer, within limits of observational error; or to follow Talbot's law of sector-disc light reduction.*

All of the observations described in this paper were made with the target stationary and with the observer's eye at rest; that is, with the image on the retina fixed in position. If the target was set in motion, the flickering at once became more noticeable. When the vanishing-flicker frequency was reached, it was usually possible to restore the flicker temporarily by directing the eye quickly from point to point over the target. If the target had been in motion, the speeds of sector-disc rotation necessary for vanishing flicker would have greatly increased.

Measurements were then made with a reduced range of flicker. The range of flicker may be defined as the ratio of the difference between the cyclic maximum and minimum illuminations upon the target, to the maximum cyclic illumination. In all of the above-mentioned observations, the range of flicker was 100 per cent.; or the illumination on the target was alternately maximum and zero, with each window and blank of the rotating sector-disc, respectively. In the case of the ordinary alternating-current carbon-arc lamps, the range of flicker is known to be large. With incandescent lamps operating on alternating-current circuits, the range of flicker depends upon the thermal capacity of the filament; that is, upon the specific heat of the filament and its mass per unit of surface. For a given alternating-current frequency within the flicker range, such as 25 cycles of current per second, giving rise to 50 cycles of flicker per second, the range of flicker is small for low-voltage, large candle-power, coarse-filament lamps, but may be large for high voltage, small candle-power, fine-filament lamps. According to the observations of Mr. J. T. Morris,† in a 220-volt, 5-c.p. carbon-incandescent lamp, with a filament of no doubt very small cross-section, the range of flicker was 63.9 per cent. of the mean illumination, which corresponds to 51.5 per cent. of the maximum, as here defined.

In order to reduce the range of flicker, the target was illuminated by two stationary incandescent lamps, side by side. One was placed behind the rotating sector-disc so as to be cyclically obscured thereby. The other was left unobscured. By varying the sizes or candle-powers of these two lamps, the range of flicker could be readily adjusted for different series of tests. The results are indicated in Figure 5. Curve *D* corresponds to 44 per cent. flicker (or 56 per cent. of the total illumination kept steady), curve *E* to 33 per cent. flicker, curve *F* to 7.5 per cent. flicker and curve *G* to 3.3 per cent. flicker. With ranges of less than 7.5 per cent., the flicker ceased to be disagreeable to the eye, especially as the frequency increased. The abscissæ of these curves are the various maximum illuminations normally incident upon the target. The observations were difficult to make in the case of the 3.3 per cent. range of flicker, and contained considerable discrepancies between the estimates of the three different observers.

The lowest range of flicker which could be recognized with certainty was 1.4 per cent., and the most sensitive flicker frequency for making it apparent was a low frequency in the neighborhood of 2.5 cycles per second. This is not far from the flicker frequency in the usual observations of mean horizontal candle-power with an incandescent lamp rotating about a vertical axis at 180 revolutions per minute, or 3 revolutions per second, and ordinarily 2 cycles of flicker per revolution; that is, 6 flicker cycles per second.

The curves *D, E, F, G* show that the vanishing-flicker frequency increases with the range of flicker, but in nothing like the same proportion.

The highest vanishing-flicker frequency that could be produced was found when looking directly at a 75-c.p. incandescing lamp through the rotating sector-disc at a distance from eye to filament of about 50 centimeters. This frequency has a mean value of 66 cycles per second, with 100 per cent. range. It was substantially the same for any angular aperture of the sector windows that permitted all of the filament to be seen at once.

Experiments with the open arc between vertical carbon electrodes and with alternating-current supply, showed that flickering, on stationary targets with stationary eye, did not entirely disappear until the alternating-current frequency was 60 cycles per second. At this frequency the flicker frequency of the arc column would be 120 cycles per second, which is far in excess

* "Talbot's Law as Applied to the Rotating Sectored Disc," by E. P. Hyde, Bulletin of Bureau of Standards, Vol. II, No. 1, 1906.

†"Experiments on Carbon, Osmium and Tantalum Lamps," by J. T. Morris, *The Electrician*, Vol. LVIII, No. 1491, p. 318, Dec. 14, 1906. His paper quotes a research by MM. Girard and Magnol in *Bulletin Société Internationale des Electriciens*, Vol. VI, pp.29-32, as stating that the ratios of difference between maximum and minimum candle-power to mean candle-power of carbon incandescent lamps on 25-cycle circuits were observed to be 15 per cent with a 110-volt, 32-c.p. lamp; 20 per cent with a 110-volt 10-c.p. lamp, and 53 per cent. with a 110-volt 5-c.p. lamp.

of any vanishing-flicker frequency with sector-disc interruption of incandescent lamps, as found in these tests. The anode glow will, however, only have a flicker frequency of 60 cycles per second, or that of the supply current; since the anode will alternately change from one carbon to the other once in each alternating-current cycle.* It would seem probable, therefore, that the light from an alternating-current arc lamp possesses two flicker frequencies; namely, one equal to that of the current and affecting the light emitted by the tips of the electrodes, and the other of twice this frequency and affecting the light emitted by the vapor of the arc, or arc stream. The sensation of flicker due to a stationary illumination-image on the retina might then be expected not to disappear entirely until both flickers exceeded the vanishing limit. If this reasoning is correct, the possibility is suggested of having less visible flickering with flaming arcs than with ordinary enclosed arcs at low alternating-current frequencies; because in the flaming arc, the light emitted from the electrodes is relatively so much reduced with respect to the light emitted by the arc stream. This question has not, however, been investigated in the experiments here reported.

The authors desire to acknowledge the assistance of Mr. S. R. Crosse in the observations here reported.

In conclusion, the following deductions appear to be warranted by the observations:

1. The frequency of flicker at which flicker ceases to be visible is approximately the same for different observers with normal sight.

2. The maximum frequency of vanishing flicker with stationary retinal image (stationary target and stationary eye) is in the neighborhood of 66 cycles per second.

3. Vanishing-flicker frequency increases in all cases when the illumination on the target is increased, but in nothing like the same proportion. The increase of vanishing-flicker frequency is rapid for increasing illuminations below 0.5 foot-candle and 100 per cent. range; and increases but slowly for illuminations exceeding 1 foot-candle.

4. Vanishing-flicker frequencies are less with colored targets than with white targets, for equal illuminations and sizes of retinal image.

5. The vanishing-flicker frequency does not depend upon the mean illumination on the target; or at least only to a relatively small degree. It depends on the maximum and minimum cyclic illuminations.

6. The vanishing-flicker frequency does not depend appreciably upon the wave-shape of flicker; that is, upon the manner in which the illumination varies in passing between the maximum and minimum cyclic values.

7. The vanishing-flicker frequency increases somewhat with the area of the target, for a given surface quality of the latter, distance from the eye, and incident illumination.

8. The vanishing-flicker frequency increases somewhat as the target is approached to the eye, for a given size of target and intensity of incident illumination.

9. The last two foregoing deductions may be jointly expressed by saying that the larger the area of retina stimulated by flicker, the higher is the vanishing-flicker frequency; but in nothing like the same proportion.

10. The greater the range of flicker, *i. e.*, the ratio of difference in cyclic illumination to the maximum, the greater the vanishing-flicker frequency; but in nothing like the same proportion.

11. The smallest range of flicker that was found to be recognizable with certainty was 1.4 per cent., observable only at a low frequency.

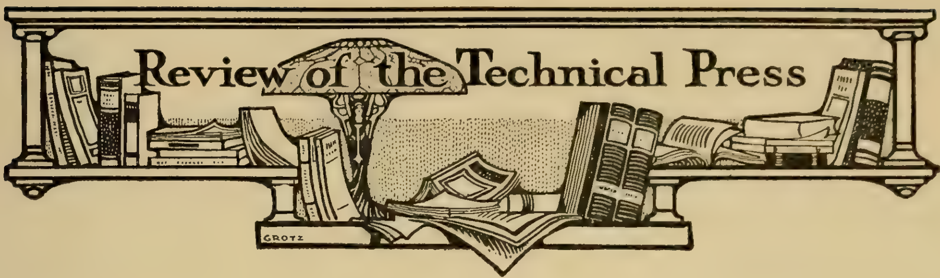
12. The most sensitive flicker frequency for small ranges of flicker was in the neighborhood of 2.5 cycles per second.

13. Flickering ceased to be objectionable with ranges less than 7.5 per cent.

14. The conditions favoring disagreeable flickering with stationary retinal images (fixed target and fixed eye) are powerful illuminations, large flicker ranges, bright surfaces of large area, and low flicker frequency.

15. The conditions tending to produce unobjectionable flickering with stationary retinal images, are feeble illuminations, small ranges of flicker, small targets and dark colors of reflecting surfaces, with high frequencies of flicker.

* Lombardi and Melazzo, "Stroboscopic Observations on the Alternating-Current Arc." Transactions of the International Electrical Congress, St. Louis, 1904, Vol. II, Figure 2, opposite p. 805.



American Items

New Books

Das Hängende Gasglühlicht, Seine Entstehung, Wirkung und Anwendung. (The inverted incandescent gaslight: Its Origin, Operation and Application). By Friedrich Ahrens. R. Oldenburg, Munich and Berlin. Price. M. 6, net.

This is a reprint in book form of the comprehensive and carefully written articles that have appeared serially in the *Journal für Gasbeleuchtung*. One of the most valuable features of the work is the large number of illustrations, of which more than 400 are given, showing the details of construction and operation, as well as the design and finish, of every form of inverted burner in the foreign trade. In the development of this form of gaslight, Germany far exceeds any other country. This fact, coupled with the well-known characteristic of the German scientist and inventor to give the most careful attention to every detail of investigation or construction, should make this book a standard treatise upon the subject.

The Lighting of Industrial Plants: *The Engineering Record*, June 15th.

Beginning with the assumption that "industrial plants, engineering works, and the like, are generally poorly lighted," the article proceeds to give some general directions for remedying the evil. The advantages of the flaming arc for night work on excavations, etc., are particularly set forth. The other suggestions are equally well chosen. It is worth remarking in connection with this article that the technical press in general is at last waking up to the importance of illuminating engineering in connection with every branch of industry. Now that the importance of the subject has been grasped, it is to be hoped that the campaign will be continued until the major premise of the article just referred to may no longer express a fact.

Municipal Lighting of Grand Rapids, Mich., by Mark Foote: *Public Service*.

The article is principally a review of a recent report made to the Common Council at Grand Rapids, by Samuel A. Freshney, General Manager of the Municipal Electric Light Plant, in which he recommends that the city give up its plant, after an experiment extending over a period of nine years, and secure its lighting by contract from the local central station.

The Lighting of Modern Garages and Grounds, by "Engineer": *American Gas Light Journal*, May 27th.

The article is devoted to an elaboration of the following statement:

Owing to the fact that a great many automobiles are operated by means of gas-

oline, or gases derived from other sources, the tendency has been to utilize equal substances in the lighting of the garage buildings and the grounds. Therefore, we find several different kinds of lighting systems in use for the modern garage and the surrounding grounds. In some cases the system of lighting is conducted with electrical wiring, regardless of the nature of the substance used for power purposes in the machines; but, as a rule, oil and gas tanks are established in the garages for the furnishing of oil and gases to the motor cars. Therefore, it becomes an easy matter to use these tanks of oils or gases for the lighting of the building, the rooms and the grounds.

GAS LIGHT GLOBE SIGNS, by "Engineer": *American Gas Light Journal,* June 10th.

Illustrations and descriptions are given of a number of schemes for utilizing opalescent globes and gas burners, or signs. While such signs in certain cases may be better than no sign at all at night, the use of gas lighting for such purposes is hardly likely to be taken seriously by illuminating engineers. It is a questionable policy to enter competition where the inherent advantages of one competitor place such a handicap upon the other.

STREET ILLUMINATION AND SIGNS IN SAN ANTONIO, TEX., by W. D. Hornaday; *Western Electrician,* June 8th.

The author says that "The electrical attractiveness of San Antonio is so great that the strangers arriving in the city at night are led to believe that a celebration of some kind is in progress." The illustrations and general descriptions given show that the statement is not a mere rhetorical exaggeration, but a plain statement of fact. The writer states that there are more than 200 electric signs in the city, requiring the use of 20,000 4-c.p. lamps, in addition to many thousands of 8 and 16-c.p. lamps. The population of San Antonio is slightly over 50,000; where is the eastern city of equal size that can make as good a showing?

PROBLEMS OF ILLUMINATION; *The Engineering Record,* May 11th.

The article is suggested by a letter to the editor in which the writer makes an appeal for more practical data on illuminating engineering, particularly as to the intensity required for different classes of lighting. The general ignorance of the public, and even of those whose business it is to handle lighting, such as engineers and architects, is shown by citing a number of exaggerated cases of defective lighting installation. In view of the common occurrence of such grossly ineffective installations, the writer concludes very properly that

> The first necessity is a sort of kindergarten educational program, entirely needless for well-informed engineers like the correspondent whose protest appears on another page, but absolutely imperative in getting the public, who have been led mainly by the blind, to realize what lights really are for, how they can be installed and used and measured, and what economies can be effected by proper design.

THE MOORE VACUUM TUBE LIGHT, AND THE ILLUMINOSITY OF GASES, by C. J. Thatcher, Ph.D.: *Electrochemical and Metallurgical Industry.*

A brief, but excellent review of the subject, giving many valuable theoretical observations.

ELECTRIC ILLUMINATING AND POWER IN THEATERS; by Dr. Alfred Gradenwitz: *Western Electrician.* The lighting of the foyer of the Opera House in Frankfort, Germany, is illustrated and described; the balance of the article pertains more particularly to the various electrical problems involved.

Foreign Items

Compiled by J. S. Dow, London.

The recent efforts which have been made to form an English Illuminating Engineering Society have as yet been unsuccessful. The *Electrician* in a recent article entitled, "The Engineering of Illumination," is inclined to disapprove of the creation of another type of specialized engineer in view of the large number of separate societies already existing, with which the unfortunate engineer is expected to keep in touch. The necessity for greater care in the utilization of light-sources is, however, fully realized and also the principle—familiar to readers of the ILLUMINATING ENGINEER, but still very generally ignored—that the formation of very bright images upon the retina, such as occur when the eye looks directly at the naked filament of a glow lamp, must at all costs be avoided.

This point is again touched upon in a paper on illumination by J. D. MacKenzie before the Glasgow section of the Institution of Electrical Engineers. (*Electrical Review,* April 26th, p. 701.)

The author deplores the continually increasing intrinsic brilliancy of illuminants, and refers to the advantages offered by the Moore light with its intrinsic brilliancy of only 1-1.5 c.p. per square inch of radiating material.

The author also deals with the vexed question of "indirect" lighting. As the loss of light from a reflecting ceiling need not be more than 20 per cent., he thinks the inefficiency of this method is usually exaggerated. From a psysiological point of view the method is good. On the other hand, like other writers, he points out that the deficiency of light and shade and consequent "flatness" of the appearance of surrounding objects (arising from the fact that the light strikes the objects from all directions) is a possible drawback.

This effect may render it difficult to distinguish objects from their surroundings. But the chief objection to indirect lighting is on aesthetic grounds. The method is unsatisfactory for the purpose of revealing a beautiful interior, the charm of which so often rests upon the contrasts of light and shade introduced by friezes, pillars and alcoves.

There have been many other papers dealing with the new illuminants. An exhaustive paper on the comparative cost of gas and electric lighting by E. G. Kennard, is reported in the *Electrical Engineer* (April 19th and 26th, and May 3rd). The paper is a very complete one and, as the author has collected together figures from many sources, should be of value for reference. It must, however, be admitted that the relative merits of different systems of lighting depend so greatly on the particular circumstances of each case that most people would hesitate to rely on a collection of results such as the above, however exhaustive and however carefully compiled.

Mr. Swinburne has recently delivered a lecture before the Royal Institution on "Incandescent Illuminants." After dealing at some length with the materials and manufactures of incandescent mantles he referred to the difficulty in deciding exactly to what cause the incandescent mantle owes its efficiency. One theory is that of "catalytic action." The mantle, it is generally admitted, must be hotter than the flame. Therefore, it is supposed that the ceria in an incandescent mantle oscillates between two states of oxidation, and in so doing assumes a temperature greater than that of the bunsen flame itself. One curious fact mentioned by Mr. Swinburne was that an incandescent mantle may apparently be darker in texture when hot than when cold. This was illustrated by experiment. The light from an arc lamp was concentrated upon a portion of a cold incandescent mantle and an image of this illuminated portion of the mark was thrown on the screen. When the gas was lighted the image became appreciably duller.

Among other experiments the operation of the new oxyacetylene blow pipe was also shown.

A new method of leading in the conductors for glow lamps was recently described by Mr. C. O. Bastian before the Glasgow section of the Institution of Electrical Engineers. (Reported, *Electrical Engineer,* May 17th.)

The ever-increasing cost of platinum has led to increasing efforts on the part of manufacturers to reduce the amount of

this material employed and in many cases this has led to the manufacture of inferior lamps.

Many efforts have also been made to replace platinum by some equally serviceable but cheaper material. An alloy of nickel and steel, for instance, can be made having practically the same coefficient of expansion as glass. Unfortunately, during the sealing in process the surface of the metal becomes coated with a film of oxide and this allows the air to gradually percolate through into the bulb of the lamp.

The essentials of a satisfactory seal seem to be:

(a) Cheapness of material.

(b) Melting point higher than glass.

(c) The quantity of gass occluded must be small.

(d) There must be no tendency to oxidize.

(e) The coefficient of expansion of metal must be appreciably the same as that of glass.

(f) The metal must be a good conductor.

Mr. Bastian describes the "Sineplat" seal which, it is surprising to find, consists simply of copper. Copper wire is rolled out to a thickness of only 0.075 mm. thickness. A 10 mm. length of soft enamel glass is then melted round this strip with a blow pipe.

If this is carefully done no oxidation occurs and the enamel adhers to the clean copper surface as solder would do.

So far so good. But it must be noted that copper does not comply with the condition (e) and we should therefore expect a strain and subsequent cracking to occur at the seal. Apparently, however, owing to the extreme thinness of the copper strip the strain is distributed in such a manner that the glass does not crack.

The "critical" thickness at which cracking is apt to occur is given at 0.1 mm.

Below this thickness cracking is said not to occur at all.

The author then describes the results of some life tests of lamps in which this seal is used. So far the results are said to be extremely satisfactory.

Attention may also be drawn to the experiments of Grau (*Elektrotechnik und Maschinenbau,* Wien, April 7th) on Wolfram, Osmium, and Carbon filament lamps.

There is still some doubt as to whether the high efficiency of the newer glow lamps is to be ascribed solely to their high temperature, or whether the element of selective radiation enters in. In this article the author describes some experiments intended to investigate the connection between the efficiency and temperature of the filaments referred to.

The curves connecting these two quantities for the Osmium and Wolfram lamps were practically identical. The curve for the carbon filament lamp was in step with them at high temperatures, but differed somewhat at low temperatures. The author thinks that this deviation can be partly explained by errors of observation.

From these curves he finds that the carbon filament lamp has an efficiency of 3 watts per c.p. at about 1660° C. This agrees with the earlier result of Lummer and Pringsheim.

On the other hand, the Wolfram lamp, at a temperature of 1850° C., has an efficiency of 1 watt per c.p. The author shows that the ratio between these efficiencies, 3, is equal to:

$$\frac{(\text{absolute temp. of Wolfram lamp})^{12}}{(\text{absolute temp. of Carbon lamp})}$$

$$= \frac{(1850 + 273)^{12}}{(1660 + 273)} = \frac{(2123)^{12}}{(1932)} \text{ approx.}$$

This being in accordance with the theoretical law of radiation of Lummer and Kurlbaum, leads him to suppose that the high efficiency of the Wolfram lamp is merely a consequence of its high temperature.

A recent number of the *Elektrotechnische Zeitschrift* gives an account of the electrical lighting of trains in Germany. On the Preusischen Staatsbohn, the carriages are lighted by two central 20 c.p. lamps, and two screened glow lamps on each side of the carriage to enable passengers to read. The arrangement of these lamps seems very satisfactory from an illuminating point of view. They are at once arranged to throw the light over the shoulder of the reader and screened in such a manner as not to be troublesome to the eyes of those seated on the opposite side of the carriage.

It is thought that the new metallic filament lamps will be particularly suitable for train lighting. Their introduction would greatly reduce the necessary lighting power, and so reduce the initial cost of installation.

Presumably, too, in this case the fact that they can only be made for a low P. D. is of no consequence.

The *Journal of Gas Lighting* for May 21st contains a translation of the first of the series of articles on the evolution of

the inverted gas light, which have lately been appearing in the *Journal für Gasbeleuchtung.*

The recent issues of the same journal also contain a series of articles entitled, "Illuminating Hints for Householders," in which the case for gas-lighting as opposed to electric light is set forth. The articles are interesting reading and it is, perhaps, not in human nature to expect judicial impartiality on the part of a gas journal defending its own branch of lighting. The author complains (we fear with some justice) of the misrepresentations of electric-light companies, and it is extremely probable that an electrical engineer reading these articles would find similar ground for complaint. The eternal controversy indeed establishes nothing more certainly than the necessity for the impartial judgment of the illuminating engineer.

The *Journal für Gasbeleuchtung* for May 18th contains a description of the application of cluster incandescent gas lamps to the indirect method of lighting.

This method has been applied successfully to the lighting of schools, but the author emphasizes the necessity for very light colored ceiling and walls. The accumulation of dust and consequent deterioration of the reflecting power of the ceiling is indeed the chief difficulty to be contended with, and—the author adds—where is more dust to be found than in the school-room? The author discusses the shape of enameled reflector which is most satisfactory for the purpose of reflecting the light upwards. The correct distance of the lamp from the ceiling naturally depends upon the size of the room to be illuminated, but should never be less than about 1 metre. If this is the case, not only does the ceiling become heated, but the warmed air above the lamp has not space to escape and the burning of the lamp becomes unsatisfactory. Units of 400 c.p. are found most convenient for indirect lighting.

The *Zeitschrift für Beleuchtungswesen* for May 20th prints an article by Mr. Lancelot Wild on the influence of gas pressure on the light from different types of incandescent burners. It is pointed out in this article that if one particular type of burner is better than another at a pressure of say 2 inches, the reverse may be the case at a somewhat different pressure.

It certainly seems clear that the gas pressure at which certain results are claimed should be specified for each burner in the same way as the P. D. across a glow lamp is specified.

Two recent articles on photometry call for comment. In the *Electrician* for May 3rd appears an abstract of a recent article by Uppenborn in the E. T. Z. on the determination of the m.h.c.p. of glow lamps. The author deals first with the accurate but tedious method of measuring the c.p. of a lamp at intervals through 360° and taking the mean. In Germany the following approximate method of finding the m.h.c.p. is often adopted. A 120 degrees angle mirror is placed behind the lamp tested so that 3 images of the glow lamp filament are simultaneously visible from the photometer screen. The lamp under test is then replaced by a standard lamp of known m.h.c.p. which is tested under the same conditions.

For the success of this method it is important that the standard lamp and the lamp under test should have the same type of filament. Even when this is the case irregularities in the distribution of light from the lamp under test are liable to effect the result.

The author also experimented with the method of spinning the lamp under test about its photometrical axis. This method, though frequently used in America, appears to be not so well known in Germany. In spite of its convenience there are drawbacks to the method. If a sufficiently high speed is used to get rid of the appearance of "flicker" in the field of view of the photometer, the filament becomes distorted, and in the case of some lamps, this leads to serious errors.

Improved results are obtained by combining the "angle-mirror" and "rotating" methods, *i. e.,* by rotating the glow lamp in front of the angle mirror. This enables a lower speed to be used and hence reduces the distortion of the filament.

Best of all, however, appears to be the method adopted at the Reichsanstalt. In this method the lamp is kept stationary and horizontal and two inclined mirrors are rotated around it. We thus obtain the advantages of the method of rotation without the deformation, errors which result from rotating the lamp. There are at present no rotation methods suitable for the new metallic filament lamps which must burn in an upright position.

Attention may also be drawn to a new form of portable photometer, due to Mr. A. P. Trotter, described in *Electrical Engineering* for May 16th.

What constitutes a somewhat new departure in this instrument is the method adopted to facilitate the comparison of

source of light which differ in color. Flicker-photometers cannot be used successfully at the extremely low illuminations often met with in street photometry. In this photometer an attempt is therefore made to employ a method supposed to depend on Crova's principle. Crova found that the total luminous radiation of an incandescent source, *having a continuous spectrum,* could be expressed in terms of the luminosity a certain ray in the yellow about λ-0.582 μ The method, however, is entirely inapplicable to sources of light like the mercury vapor lamp which gives a spectrum consisting of isolated bright lines.

In Mr. Trotter's photometer the method consists in altering the color of one or both of the sources of light by means of colored screens, so as to secure a color-match, and, when necessary, allowance is made for the amount of light absorbed by such screens.

The value of such a method as this is very questionable in the case of accurate photometry, but it may serve to secure the approximate results desired in the type of work for which the photometer is presumably intended. It must be pointed out, however, that tinted surfaces of this type cannot be said to employ Crova's method, for the colors of yellow screens must at best be extremely impure, allowing a very large amount of white light to pass, and Crova's method applies to a very narrow region of pure spectral yellow.

Summary of Papers on Illumination and Photometry

Electrician.—April 12th. p. 1014. "The Engineering of Illumination." April 12th, "The Effect of High Efficiency and Lamps on the Electric Lighting Industry" (W. Tatlow. I.E.E. Dublin Section). May 3rd. p. 87. "The Determination of the M.H.C.P. of Glow Lamps" (Uppenborn, abstracted from E.T.Z., Feb. 21st, 1907). May 3rd. p 94. "Incandescent Illuminants" (Swinburne, lecture at the Royal Institution, April 26th).

Electrical Engineer.—April 19th and 26th, and May 3rd. "The Comparative Costs of Gas and Electric Lighting" (E. G. Kennard, I.E.E. Students' Section). May 17th. p. 688. "A New Leading in Conductor for Electric Lamps" C. O. Bastian, I.E.E. Glasgow Section).

Electrical Review.—April 26th. p. 700. "Illumination and Some Illuminants" (J. D. Mackenzie, I. E.E. Glasgow Section).

Electrical Engineering.—May 16th. p. 849. "A New Portable Photometer."

Journal for Gas Lighting.—May 21st, and previous issues. "Illuminating Hints for Householders." May 21st. p. 526. "The Evolution of the Inverted Gas Light."

Elektrotechnisch Zeitschrift.—April 25th. p. 435. "Electric Train Illumination."

Elektrotechnik und Maschinenbau, Vienna.—April 14th. p. 295. "Temperature and Light-Emission of Carbon, Osmium and Wolfram." By A. Grau.

Journal für Gasbeleuchtung.—April 6th. p. 298. "A New Procedure for the Manufacture of Incandescent Bodies Where Copper Celluloid Was Used as Oxide-Carrier." Bruno, Berlin. May 4th, and previous issues. "The Development of the Incandescent Light." May 11th. p. 435. "Gas-Lamps (Incandescent) for Railroad Trains, With Inverted Burners." May 18th. p. 463. "Most Suitable Construction of Space and Construction of Lamps and Burners for Indirect Illumination."

Journal für Beleuchtungswesen. — May 20th. p. 147. "Influence of Gas Pressure on the Effect of Burners." By Lancelot Wild.

Friedrich Upperborn

Friedrich Uppenborn died after a brief illness on the twenty-eighth of March. He was one of the most prominent electro-technical workers in Germany. At the time of his death he was director of the municipal electric works of Munich.

Mr. Uppenborn was born January 29, 1859, in Hannover, the son of a high school teacher. As a boy he demonstrated unusual talents and inclination toward mathematical and physical studies, and was carefully trained in these subjects by his father. After being graduated from the high school, he entered the Polytechnical College at Hannover. His visit at the Parisian World's Fair in the year 1888 determined his future career.

In Paris he was deeply impressed by the achievements in the field of applied electricity. In 1880, while yet a student, he already had had published in the *Zeitschrift für Angewandte Elektricitätslehre,* a series of articles, chiefly on electric lighting. At the close of 1880 he accepted the editorship of that paper, in which he then published many very useful scientific and technical articles.

During his long stay in Paris he came in contact with men prominent in science and the useful arts, especially with Werner von Siemens, William Siemens, Haefner-Alteneck, Schuckert, Guelcher and others. Schuckert employed him later in his works as chief engineer. After a year and a half of activity in that capacity, he started a machine factory of his own in Hannover. He soon sold this establishment, however, in order to devote himself to the duties of the manager of the electro-chemical laboratory founded by the Polytechnical Society of Munich. At the same time he carried on the duties of editor of the *Zentralblatt für Electrotechnik.*

At the close of the year 1889 Mr. Uppenborn moved to Berlin, where he took up the editorial work of the *Elektrotechnische Zeitschrift* connected with the *Zentralblatt.* This publication attained the highest standard of excellence under his management, and he himself continued to furnish valuable material up to the very end.

Besides his literary activity in Germany and abroad, Mr. Uppenborn originated a work of especial usefulness, namely the *Kalender für Elektrotechniker,* which has lately entered its twenty-fourth year.

During the last two years of his life he also edited a Swiss and Austrian edition of the *Kalender.*

A volume on technical photometry remains unfinished, but will shortly appear as his posthumous work.

The municipality of Munich offered to him the position of chief engineer of its electrical works in 1894, which he accepted. This was a broad field for Uppenborn's unusual scientific and technical talents. His first work in this field was the extension of the street lighting system from 210 to 550 arc lamps during the first year. This placed Munich at the head of all European cities in the matter of illumination. A considerably more important task undertaken by him was the erection of a great electrical plant. This was equipped with the best instruments, having sub-stations and a net of cables over the entire city. The enterprise was so successfully managed by him that a year before the contract of the gas light company expired, in 1898, electrical energy could be furnished by the city to private consumers. He also took active part in the promotion of the municipal street car service and founded an electric laboratory connected with an electric testing station.

It was through the acquirement by the city of Munich of the franchise for the water-power station near Moosberg that Mr. Uppenborn achieved his greatest renown, though he was never destined to see the completion of this marvel of engineering which he had supervised with such care. The city of Munich gave this power station the name of its creator, "Uppenborn," in order to link his name forever with this, his latest work.

The advice of Mr. Uppenborn was solicited by many cities in Germany and abroad. He never ceased to look with great interest for the upbuilding and advancement of the "German Electrical Engineers' Society," to whose executive committee he always belonged.

In 1890 Mr. Uppenborn was elected president of the "Vereinigung der Elektricitätswerke," having at that time 104 members. He was here especially active as a member of the editorial committee. From 104 the members of that institution increased to nearly 300, world-wide fame having been attained through the influence of Mr. Uppenborn.

Miscellaneous News

ALEXANDRIA, IND.—The municipal lighting plants in this city and Fairmount, which have been in operation several years, have passed to the Central Indiana Lighting Company, which has bought all outstanding bonds and paid the floating debts. The municipal service was unsatisfactory and the cost in excess of what it would have been under private ownership, which led to increased taxation and consequent complaint from taxpayers.

MEDFORD, ORE.—Dr. Ray, manager of the Condor Power Co., who recently purchased the Medford lighting plant, tendered a banquet to the Commercial Club, and began the installation of a modern arc system of street lighting. For the first time in its history Medford is using arc lights for street lighting.

LOS ANGELES, CAL.—The principle of municipal ownership and operation of lighting plants has been materially strengthened by the action of Judge Olin Wellborn, sitting in the United States Circuit Court, who has denied the petition of the Edison Electric Company for an order restraining the city of Pasadena from disposing of $125,000 bonds, voted May, 1906, for the acquisition or erection of a municipal lighting plant. Judge Wellborn also sustained the demurrer of defendant to the third amended complaint. The decision affects vitally both municipalities and corporations as the ground taken by H. H. Trowbridge, attorney for the Edison Electric Company, was that the establisnment of a municipal lighting plant would be unconstitutional because it would be exempt from taxation, putting the competing private corporation at a disadvantage.

ST. LOUIS, MO.—A mutual electric lighting company is projected for residents of the thickly populated suburban towns of St. Louis County. Its formation is being urged by B. H. Matthews, and a number of residents of Wellston and Clayton. Nothing definite has been done toward its organization, but the plan will be submitted to the residents of Maplewood and Greenwood. Each of the subscribers to the mutual stock will sign for $100. It is hoped that at least 1,000 subscribers can be secured, and maybe 2,000. Each person subscribing will be furnished electricity for any purpose at cost. There are to be no profits, all net earnings going to a reduction in the price charged for the commodity.

TORONTO, CAN.—The Government of Ontario has taken a new step in the direction of distributing the benefits of Niagara power among its citizens. It has concluded a contract by which a generating company is to deliver to it 35,000 horsepower at $10.40 per year for each. The Government is to build trunk transmission lines, or secure their construction by private capital, and send the electric current over these wires through a circuit of sixteen of the principal cities of the Province. The municipalities will arrange for its local distribution, at prices estimated at from $16 to $24 per horse-power per year. With this perennial source of energy on tap, the cities of Ontario will be able to try the experiment of the municipal ownership of lighting plants and traction systems under the most favorable conditions. They are not limited to the amount of power specified in the contract. If they need more, they can get all they ask for at the same price. And if they make their enterprises successful other places may follow their example until in time every town and village in the Province is attached to the Niagara harness. The three power companies on the Canadian side of the river have the right by their charters to develop 405,000 horse-power in all, but they have not yet come anywhere near their permitted limits. Before they do the Government may have arranged to handle their entire output.

Extracts from the Opinions of Judges

U. S. Circuit Court of the Southern District of New York

On Holophane Reflectors and Patents

HOLOPHANE GLASS COMPANY, by O. A. Mygatt, Pres., *vs.* DAVID M. GILBERT.

"An examination of the defendant's shade reveals a most palpable imitation of, absolute identity of construction with the complainant's patented article." Extract from Judge Hough's opinion.

HOLOPHANE GLASS COMPANY, by O. A. Mygatt, Pres., *vs.* E. L. ZALINSKI & ILLUMINATING ENGINEERING COMPANY.

"The reflectors are all that is claimed. The evidence fully sustains the claims of the patent. . . . The Defendant is making and selling substantially what the Complainant is making and selling. . . . In some there are slight changes, but these changes are evidently made to be used in justifying the infringement, if possible. THE DEFENDANT'S SHADES ARE BALD APPROPRIATIONS OF THE COMPLAINANT'S PATENT. . . . The Court is of the opinion that the patent is valid, and that the Defendant infringed. There will be a decree for an injunction and an accounting." Extract from Judge Ray's opinions.

HOLOPHANE GLASS COMPANY, by O. A. Mygatt, Pres., *vs.* PRISMATIC HOOD COMPANY.

"This Court recently considered and held valid a similar patent (See Mygatt *vs.* Zalinski, 138 Fed. R., 88.) That decision has been acquiesced in. This is a different design, but all that was said there on the question of validity applies here. So of infringement. Defendant makes the same thing, uses the same design, except that a slight cut is made around the reflector about half way from the upper to the lower edge of the reflector. This slight change which slightly impairs the design of Complainant's patent but appropriates it bodily, does not avoid the charge of infringement. There will be a decree for an injunction with accounting." Extract from Judge Ray's opinion.

HOLOPHANE GLASS COMPANY, by O. A. Mygatt, Pres., *vs.* McKENNY & WATERBURY.

Confirming and sustaining Judge Ray's opinion, Judge Lowell in the Circuit Court of the U. S. District of Mass., held the HOLOPHANE reflector patent to be good and valid, granting a permanent injunction with accounting.

List of Holophane Patents

Mechanical Patents. 563,836, 593,348, 655,728, 666,683, 679,770, 679,771, 687,848, 705,426, 732,211, 735,796, 736,535, 742,345, 755,687, 762,925, 762,926, 762,927, 12,358, 763,689, 776,079, 763,688, 792,606, 804,253, 804,254, 804,334, 805,742, 821,306, 821,307, 821,308, 821,309, 821,310, 821,311, 823,619, 823,620, 823,621, 823,622. Other patents pending.

Design Patents. 30,266, 36,215, 33,996, 35,616, 35,682, 35,683, 35,684, 35,755, 35,756, 35,757, 36,214, 37,809, 37,824, 37,825, 37,946, 37,832, 37,833, 37,834, 37,835, 37,808, 37,812, 37,924, 37,960, 37,984, 37,967, 37,981, 37,982, 37,983, 37,985, 38,005, 38,006, 38,026, 37,813, 36,126, 38,558, 37,961, 38,543. Other patents pending.

HOLOPHANE GLASS COMPANY, NEW YORK

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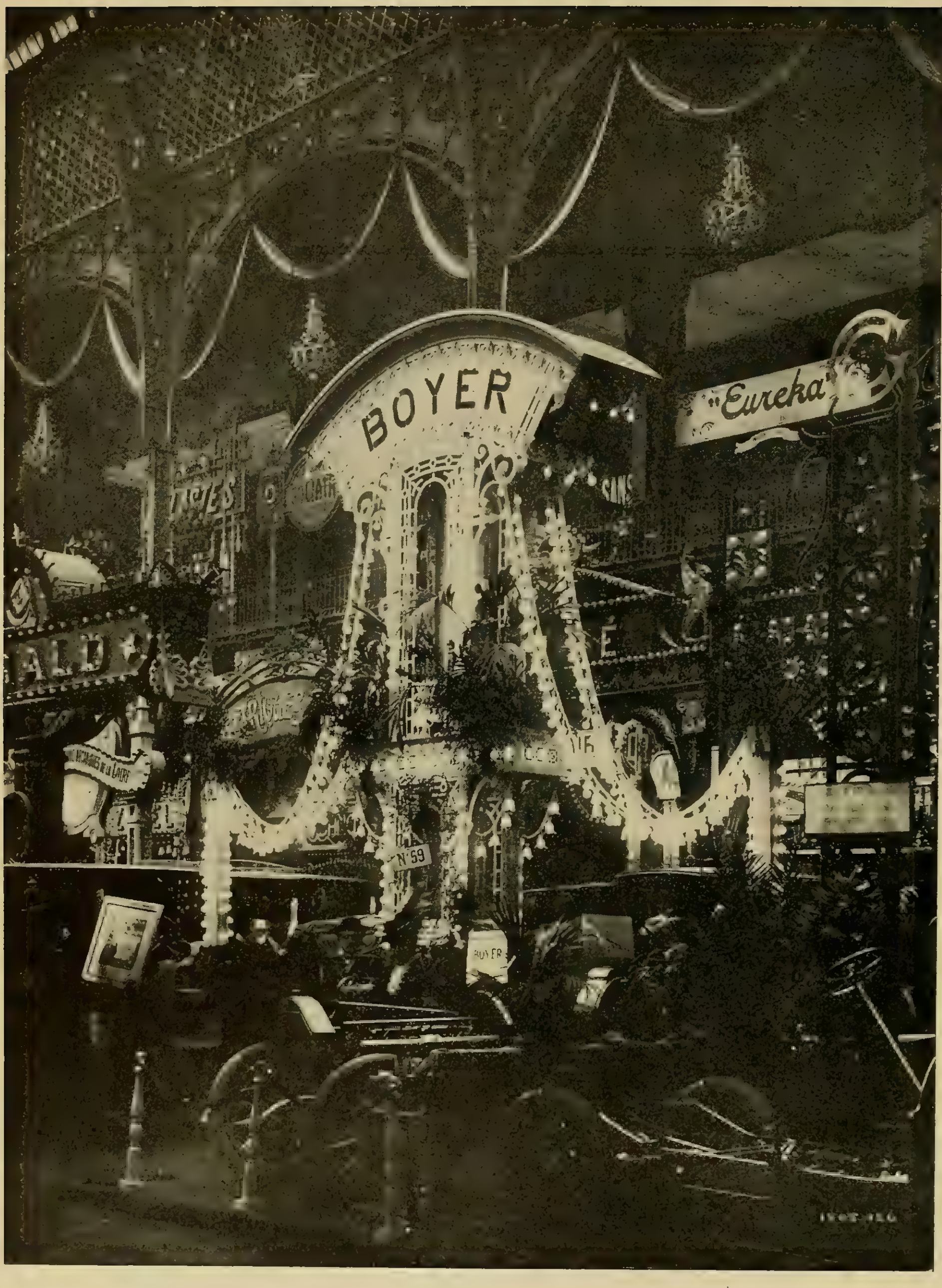


TYPICAL DECORATIVE ILLUMINATION AT THE PARIS AUTOMOBILE SHOW.

THE ILLUMINATING ENGINEER

Vol. II. JULY, 1907 No. 5.

The Illumination at the Exhibition of the Automobile Club in France.

By Bernardo da Costa.

The International Exposition of the Automobile Club of France in 1906 included two main groups: The carriages, motorcycles, and bicycles, and their accessories, in the Grand Palais des Champs Elysèes; and the delivery wagons, trucks, and omnibuses in an improvised annex on the Esplanade des Invalides.

If the perfection and the multiplicity of the objects exhibited attracted the specialist, his eyes, as well as those of persons that had come out of sheer curiosity, never failed to be dazzled by the beautiful decorations and the marvelous light that streamed from all parts of the foyers, as well as from ceilings and walls.

Aside from the gas works which supplied that part of the Champs Elysèes situated between the Place de la Concorde and the Rond Point, the Avenue Nicolas II as far as the Annex, and certain features of the interior decoration of the façades, and for emergency lights, and for heating, electrical energy, estimated at 3,300 kw. was furnished by the following five stations:

At the Grand Palais:

1. The station of the Société Lacarriere installed in the basement of the Grand Palais des Champs Elysèes, which produced 150 kw., direct current, supplied 100 flaming arc lamps, System Vigreux & Brillie, 200 mercury vapor lamps, and the elevators.

2. The sector of the Champs Elysèes was supplied from the substation in the Avenue d'Antin, which transformed an alternating, single-phase current of 3,000 volts into 110 volts, and furnished 300 kw. to the exhibitors, and part of the avenue.

3. The Metropolitan Co., by means of two branches of a three-phase current of 25 cycles and 5,500 volts, supplying two groups of three transformers each, giving a total of 1,800 kw., furnished light for the ceiling, the nave, and part of the exhibition.

4. The Westinghouse Co. by two circuits from the high-tension system,

THE DE DION BOUTON BOOTH.

5,500 volts, of the Western R. R. Co., furnished 500 kw.

At the Esplanade des Invalides:

1. The section of the Rive Gauche furnished 50 kw. in single-phase alternating current of 42 cycles.

The Westinghouse Co. by means of a substation similar to that of the Grand Palais, furnished 450 kw. in the shape of three-phase alternating current of 25 cycles, and, by the use of two Rouge & Faget rectifiers, could furnish also 100 kw. of direct current of 110 volts.

Besides these, some exhibitors produced their own illumination.

The apparatus for utilizing this huge amount of energy was distributed in the following manner:

At the Grand Palais:

Ceiling: 15,000 5-cp., 110 v. lamps, mounted on flexible cords and pendants.

Grand Stairway and Administration: 5,000 lamps; booths of the exhibitors, 100,000 lamps.

In various places in the building, in order to obtain a grand illumination, and for producing special light-effects, 200 Cooper-Hewitt lamps (800 c.p.), consuming 3,5 amperes, of which there are 60 in the colonnade

of the façade, 12 under the chandelier and 12 above, under the dome of the Grand Palais.

In the galleries of the first floor: 100 flaming arc lamps, Vigreux & Brillie, running on direct current at 110 volts.

The decoration of Avenue Nicolas II consisted of 1,500 5 c.p., 110 v. lamps, distributed evenly on flexible cables.

At the Annex the illumination was obtained by means of carbon arc lamps, System Blondel, and Volta lamps; the emergency illumination consisted of petrol vapor, Lux lamps.

By the number of lamps (100,000) used for the private lighting of the booths, it is evident that a profusion of decorative illumination could be given them. Some of these lamps were of the ordinary kind, or with pointed bulbs decorated wrought-iron fixtures, while others were "electric pearls, system Weissmenn. We give photographs of the handsomest stands belonging to these two types of decoration.

The illustration shows that the Weissmann system permits of an easy realization of new decorative effects, such as garlands, festoons, pendants, etc.

After this general glance at the lighting systems represented, we will describe the characteristics of each system in the following order:

I. Electric Lamps,

II. Acetylene Lighting,

III. Miscellaneous Lighting.

I. Electric Lamps.

Mercury Vapor Lamps.

Cooper-Hewitt Lamps. The reputation of these lamps in the United States, where they were invented, and where they are employed more extensively than elsewhere, make it unnecessary for us to enlarge on a subject that is well known to all your readers. The types used in France are 1.2 m. and 0.55 m. long, having respectively a nominal intensity of 800 and 350 c.p. They take uniformly 3.5 amperes on 110 v. These lamps were largely used in the building for producing decorative effects, or for obtaining a large amount of diffused light; the only type adopted was that of 800 c.p. (1.20 m. in length).

Belliot and Reiss Lamps. At first sight this lamp differs little from the Cooper-Hewitt. The electrodes at the end of the tube are of carbon, instead of soft iron, as in the preceding type. The color of its light appears a little less green than that of the Cooper-Hewitt, which fact is due to incandescent lamps with red filaments which are added so as to absodb the excess in voltage between the circuit and the lamp, and to overcome the lack of red rays. Its consumption varies according to the length of the tubes. Those of 45 cm. length absorb 3 amp. at 110 v. and give an intensity of about 400 candles. The carbon electrodes seem to introduce impurities into the tube, and, consequently, the luminosity and life must be less than in the preceding lamp.

Lamps of the General Electric Co., System Bastian. These are lamps of reduced dimensions, with automatic starters, and an airtight covering on the exterior. They are distinguished by having mercury electrodes. The surplus of non-vaporized mercury during the operation of these lamps is driven towards two small reservoirs placed at the ends of the tube, where it plays the rôle of electrodes. Their luminous intensity is about 90 candles and their average consumption at 110 volts 0.7 ampere. When lighting the consumption always rises to about 3 amp. for a very short time.

On account of its small consumption of current this lamp may be used on

AN ITALIAN BOOTH, DECORATED WITH "LUMINOUS PEARLS."

installations of incandescent lamps already in use, without having to change the wiring.

The life of these lamps is, like that of the preceding ones, from 3,000 to 4,000 hours, and like for the former, it suffices at the end of this time to replace the mercury tube.

In order to diminish the color effects of the mercury vapor's light, an incandescent lamp is added, which at the same time serves for additional resistance.

Arc Lamps.

Lamp "Economique," System A. Bellardent. Of the ordinary (non-

mineralized carbon) arc lamps exhibited we will only mention the "Economique" lamp, system, A. Bellardent.

On account of their very small dimensions (40 and 46 cm. in length) and their simplicity, the Bellardent lamps are very convenient to use. They are designed to work in series on 75 to 100 volts and from 1.5 to 3 amperes direct, or 3 to 3,5 amperes alternating current. They are also made to run on 200 volts and more; each group of lamps taking from 2 to 3.5 amperes direct, or 3 to 3.5 amperes alternating current.

Carbons from 220 x 5 mm., to 240 x 6 mm., have a life of 12-20 hours on direct current, and on alternating current, where only carbons of 240 x 5 mm. are used, it amounts to 15 hours.

The regulation of these lamps is very satisfactory, as they can work quite well on alternating currents of low frequency, 25 cycles, according to the inventor.

Mineralized Carbon Lamps, System Vigreux & Brillié. It is a well-known fact that the use of mineralized carbons in arc lamps adds materially to the amount of light produced and that, moreover, this increases with the degree of mineralization. However, the use of these carbons in ordinary lamps meets with serious obstacles, such as the scorification, mineral fumes, flickering of the light, instability of the arc, etc. These difficulties have led inventors to use their ingenuity in the construction of new lamps better adapted to the use of mineralized carbons.

We will mention first this mineralized carbon lamp, System Vigreux & Brillié, owing to their large use at the Exposition. The model employed for lighting galleries of the first floor of the Grand Palais was the one in which the carbons are in an inclined position. The installation permitted of 100 direct-current lamps connected three in series on 110 volts, and two in series with rheostat.

The candle-power of convergent mineralized carbon lamps, System Vigreux & Brillié is about four times that of ordinary lamps. They consume about 0.3 watt per spherical candle.

Lamps of the "La Lutèce Electrique." The entrance to the booth of the firm of Masson as illuminated by lamps of this company, which controls the "Excello" in this country. This lamp also has the carbons in the convergent position. Steadiness of the light is obtained by choosing carbons of the smallest diameter possible, but not too fragile.

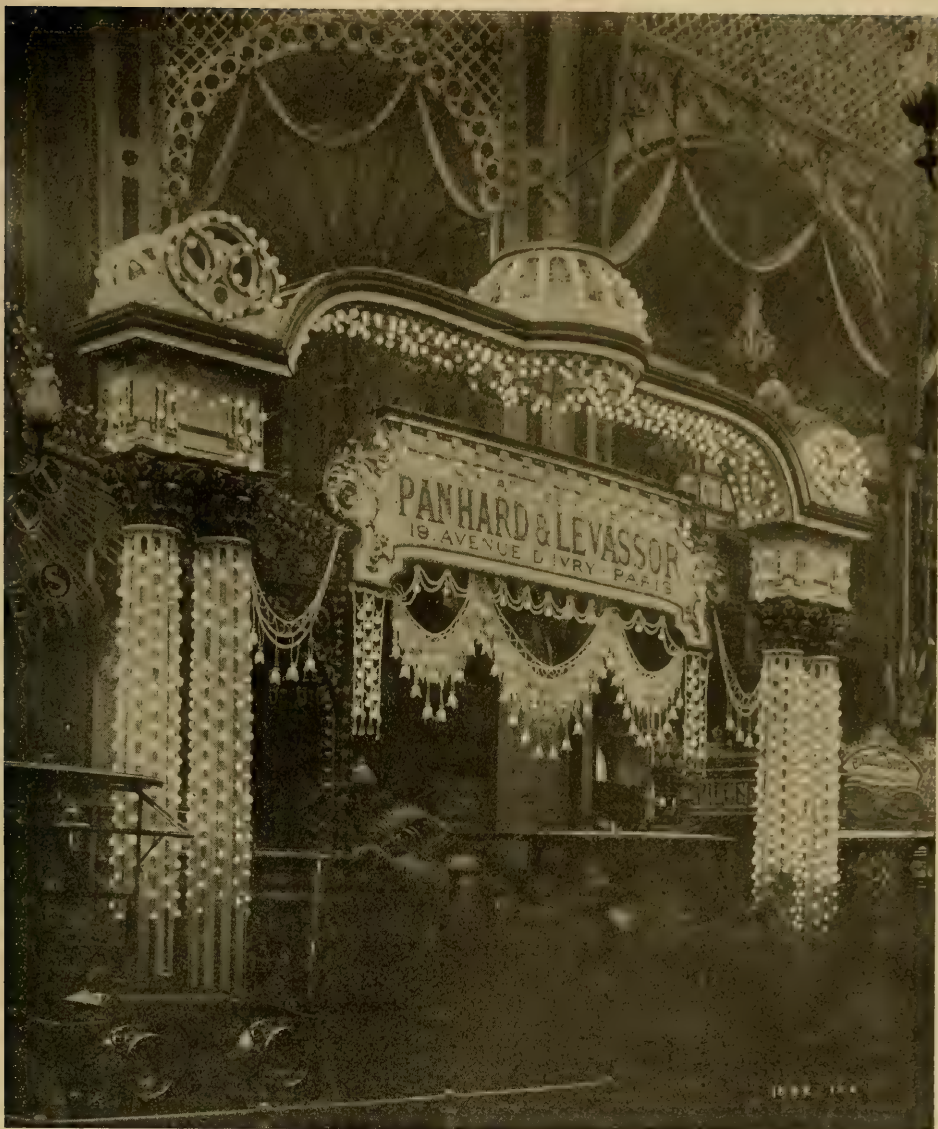
The luminosity is increased by employing thin carbons, slightly mineralized so as not to stick and by letting them burn under a shield of refractory material. This latter, barring the access of air in the closed globe, keeps the temperature of the arc at its maximum, at the same time reducing the consumption of the carbons.

Auer Co. Lamps. In view of the fact that the addition of certain mineral substances to the carbons increases the luminous power of the arc in proportion as it becomes saturated with the volatilized substances, in the lamps with "dizone" mineralized carbons, System Blondel, the carbons are used in the ordinary position, one above the other, in preference to the convergent position. The inclined position of the carbon necessitated the use of very long, thin carbons which a strong mineralization has rendered very fragile, which have a high resistance, in order to last a sufficient number of hours.

That which characterizes the System Blondel, of which the Auer Co.

MINIATURE LAMP, WITH DELICATE METAL WORK.

controls the patent, is the possibility of obtaining with strongly mineralized carbons of ordinary diameter, which are slightly fragile, and which have a normal life and electrical resistance, lamps of very small consumption, as well as a great steadiness of light, and an efficiency the highest ever attained. This result is obtained from Blondel lamps by means of the special composition of the carbons. The examination of the rôle of the different zones of the carbon in the production of the electric arc led the inventor of this system to construct a carbon of several zones or layers, each of which is composed of appropriate substances. The "dizone" carbons are formed of two concentric layers. The central core, which produces the arc,



A COMBINATION OF "ELECTRIC PEARLS" AND ELECTRIC LAMPS.

is very strongly mineralized. It is encircled by a layer of pure carbon which serves for protecting it, and which, when brought to incandescence, is consumed by combustion in the air, and does not enter into the production of the arc.

Contrary to the arrangement adopted in ordinary arc lamps, in the Blondel lamps the *arc is reversed* by putting the positive carbon at the bottom and the negative at the top; the incandescent mineral vapors which are lighter than the air naturally rise into the arc, and give to it a luminosity almost uniform for its entire length, thus increasing the light 25%. This arrangement also prevents the scorification of the tip of the negative carbon. According to tests made by Dr. Mo-

nasch, of Berlin, the efficiency varies from 0.11 to 0.15 watts per hemispherical candle, according to the intensity of current and the voltage at the terminals. The direct current lamps are designed to run 2, 3 and even 4 in series on 110 to 120 volts. The efficiency (watts per candle), varies relatively little with these different connections. provided that the power absorbed in the arc be the same. The current varies from 4 to 18 amp. and the voltage from 44 to 27 per lamp. The diameters of the positive carbons are from 9 to 15 mm. and those of negative from 6 to 10 mm.; their hourly life varies from 17 to 26 hours.

The Pierson stand at the annex was illuminated by means of 42 arc lamps (Auer.) of the 7.5 amp. type, connected 3 in series on 115 volts d.c. produced by a generator driven by a Pierson gas engine.

The "dizone" carbon arcs have practically the same consumption per candle with the alternating current as with the direct, and have the advantage over the ordinary arcs of being capable of working on much lower frequencies. We had the opportunity, at the Samson stand in the Grand Palais des Champs Elysèes, of observing three Blondel lamps of the 15 amp. type, connected in series of 110 volts alternating with a frequency of 25 cycles. The common kinds of alternating current lamps vary from 8 to 12 amperes on 30 volts, with a mean power factor of 0.85.

Incandescent Lamps:

The consumption of 1.2 watt per candle does not interfere perceptibly with the life of the lamp.

The light emitted by the M. S. lamp is white, agreeable and constant during the entire life of the lamp, which easily attains 200 hours.

These lamps burn in all positions for voltages of from 2 to 10 volts, but for 12 volts the vertical position seems to give the lamp a longer life.

Owing to their small consumption of current M. S. lamps allow, with the same service, the use of much lighter and more economical accumulators than carbon filament lamps.

Zirconium Filament Lamps.—Though still new in commerce these lamps deserve to be particularly mentioned on account of their great luminous intensity and their very low current consumption. As the zirconium filament is very fragile, the Lacarriere Company sought the means for giving it a higher degree of mechanical strength. These researches were successful, the use of certain alloys of zirconium affording the secret of the achievement. These lamps are made for 20, 35 and 60 candles at 110 volts; they give a very white light, and consume *only one watt per candle* during their life of more than 800 hours.

II. Acetylene Lighting.

Universal Acetylene Co. The apparatus for industrial and domestic lighting manufactured by the *Universal Acetylene Co.* are so well known that a detailed description would be superfluous.

The acetylene-producing apparatus may be divided into three general classes: "Contact." "Carbide-to-water." "Water-to-carbide."

Among the advantages which the last class of apparatus offers the following are the principal ones: Possibility of rigorously limiting the production of gas to the needs of consumption; action on the carbide by water that is always clean and not charged with lime; *absolute certainty of proper action,* owing to the possibility of stopping the whole mechanism. The Universal Acetylene Co. has given preference to the apparatus of the third class in adopting the "He-

A BEAUTIFUL ARRANGEMENT OF INCANDESCENT LAMPS.

liogene" apparatus, System Capelle La Croix.

"La Bougie Desq" Company. This company exhibited their system of generators, and also a portable lamp for the use of the *"Desq Candles."* These "candles" consist of a carbide composition which leaves only a light, sandy, odorless residuum, that does not soil the apparatus. The lamps use a Welsbach burner, giving high intensity of light, very steady, and of white color.

III. Petrol Lamps.

"Lux" Light. The Lux lamp is an application of the thorium mantle of Dr. Auer on Welsbach to petrol burners. The petrol is put into a reservoir placed either in or near the lamp. For open air illumination these reservoirs contain as much as 40 litres, which is placed in the lamp-post. Inside this reservoir there is carbonic acid led by a tube into a small petrol receptacle containing from 2 to 8 litres, which refill itself automatically when the apparatus is not in action

Noel Burners. The firm of Liotard Bros. exhibited their incandescent apparatus, system Noel, using ordinary mineral oil. Illumination by mineral oil piped into the houses like gas is a very widely known means of lighting. This system is conspicuous by its great simplicity. An installation of Noel lighting apparatus is composed of a simple oil reservoir that is placed underground, fitted with an opening for introducing the oil, a manometer, a valve which serves for opening and closing the flow of the liquid from the reservoir to the pipes, and a valve for admitting the air, which gives the necessary pressure to the reservoir by means of a simple bicycle pump.

Theory and Technology

Fixtures—Good and Bad

By H. R.

Success in selecting what is in comfortable good taste without having to pay the price which lies beyond what one can really afford, comes from knowing where to look. This is true in all things, but particularly so in the matter of lighting fixtures. This is due mainly to the fact that the majority of salesmen do not so much concern themselves with the particular requirements of each and every case from an artistic point of view, as in making sales—and perhaps that is only natural.

The purchaser is often enough far from knowing what he wants. It can hardly be otherwise, for when one has spent practically his entire time and energies making enough money at his own particular calling to build a house, he can hardly be expected to be altogether capable in making a proper choice in the matter.

"Style," as the word is commonly used, suggests that which is good and proper, the right thing in the right place—that which is "neat but not gaudy"; that which one can enjoy the more as time goes by and (recognizing the fact that we all live in more or less fear of what our neighbors think of us) that respectability in our household gods that gives us assurance that friends will not come and call and think things that they would not say to us.

One of the unfortunate phases of the fixture situation doubtless lies in a too prevalent tendency toward "straining for effect." The ordinary person borne down with the cares of house-building, by the time the question of fixtures has arisen (which is almost invariably the last) has reached a point where a good salesman can, indeed, be a friend in need; left to his own resources he may select something that *is* wrong, and that he *suspects* is wrong. All he needs is good advice. The salesman who has taken pains to study into the subject and has become an artist in his line, prepared on occasion not only to give advice but to tell why, may have his troubles like everyone else for holding by his convictions to a reasonable degree; but he stands a better chance in the end than the timid type who is all "yes, sir, you're right, sir; just as you say; thank you, sir."

It is related that a prominent fixture company, upon being consulted in regard to fixtures for an installation of more than ordinary interest, carefully investigated the case. The prospective customer was offered several choices in the selection of fixtures which would doubtless have reflected

FIG. 1.

fair credit to all concerned. But no—the prospective purchaser would have none of these, insisting rather upon a combination that seemed to the manufacturers to be at such atrocious variance with everything that lay within the realm of good taste that a protest was offered by the company; it would do almost anything but that which was suggested—anything! It was "impossible," this particular combination.

The company held, with expressed good faith in the matter, that sooner or later their clients would surely be displeased with the results along the lines to which they were adhering, to the end that, as the story goes, with the best of business friendship existing, the company finally pleaded permission to withdraw rather than perpetrate what, to its conviction, would have proved most unsatisfactory. The company refused to perform the operation, so to speak, and the opportunity of doing so passed to some more amenable concern. This company claims, however, that it has gained far more than it has lost by such procedure.

Its manager, in setting forth this position, said: "What is the use in our having a standard unless we are to stick to it? If we have a fair name and would hold it, we must protect it, mustn't we? Besides, may we not protect to the best our knowledge the interests of our customers? That has been our custom for years and we are still doing business.

"An acquaintance of mine, for instance, recently came to me for advice. He had a pretty good house, but had come to a point where he realized that he must economize on his lighting fixtures. All well and good. I suggested that he cut his selections to the point of simplicity rather than install some pieces of elaborate design, the very weakness of which would be evident with the appropriations available. Because a piece is simple in its conception it need not necessarily show cheapness. There's nothing very remarkable about that, is there?"

FIG. 2.

FIG. 3.

GOOD FIXTURES.

As an illustration of such work the following designs were offered as suggestive:

Fig. 1 shows a simple bent arm, with lines that follow according to the description of the designer. This design has the advantage of being harmonious in any simple room and commends itself as being of that character of which one would not tire. It would look well in a house that might have no great pretensions or in one that was fairly expensive in its appointments.

Fig. 2 is a good example of the old order of lamp that has not been affected by the introduction of electricity and is strong from the standpoint of proper illumination; while still retaining the effect of an oil lamp it suitably adapts itself to modern conditions. It might well be used in the English, Colonial or Dutch style of house.

Fig. 3 is a bracket built along Colonial lines, successfully concealing the mechanical appliances necessary in the use of electricity, the arm terminating as it does in the flower-like effect which conceals the electric socket in which the glass follows the lines of the shell that holds it. This also is a piece of which one certainly would never tire and is an ornament as well as a lighting piece.

Fig. 4 shows a bracket along the lines of the new order of work. The bracket has been studied to produce harmony and, as in the other instances the ugly mechanical effects have been concealed.

Fig. 5 might be best classified as a bracket of the older order of work. Pieces of this kind might have been found in the old world castles. The charm of the design is retained even with the modernizing necessary to comply with present day lighting.

ON THE CONTRARY.

In extreme contrast with the design heretofore shown, some anonymous

FIG. 4.

DIAGRAM NO. 5.

creations indicating general weakness are submitted; by weakness is meant particularly a lack of purpose in any direction whatever and suggestive of an effort toward decoration which is unsuccessful because of glaring inconsistencies. For instance, it is noted throughout that one part at least of the fixture shows a suspicion of a motive that, even if it were well executed, is at complete variance with the other parts, they in turn bearing little if any resemblance to one another.

Fig. 6, for example, is a piece entirely out of proportion at its inception; no amount of alteration in the component parts in respect to design could remedy it. It belongs to no style, to no period, unless one were to take the fact of its existence for *a priori* proof that it must be placed in the motley gallery apportioned to the vaudeville of genuine artistic effort.

To be more specific, Fig. 6 has a weak back. Atlast never in his weariest moments looked more burdened than this back piece looks, supporting as its meted incubus the two immense bulbs that droop as if on the point of collapse. Even if the back were strong enough, the arms are not. In respect to the decorative effect there is again trouble: The back suggests, if it suggests anything, a French motive, while on the bulbs is a pattern that savors of the Greek of the Empire period. Of this "gilt and glitter," which only at its very best is endurable, one would surely tire, and its cost would undoubtedly be greater than a fixture that is much better from the standpoint of grace, beauty, proportion and essentially everything else that makes for good taste.

Fig. 7 offers as its most glaring fault a wreath, the excuse for whose

DIAGRAM NO. 6.

FIG. 7.

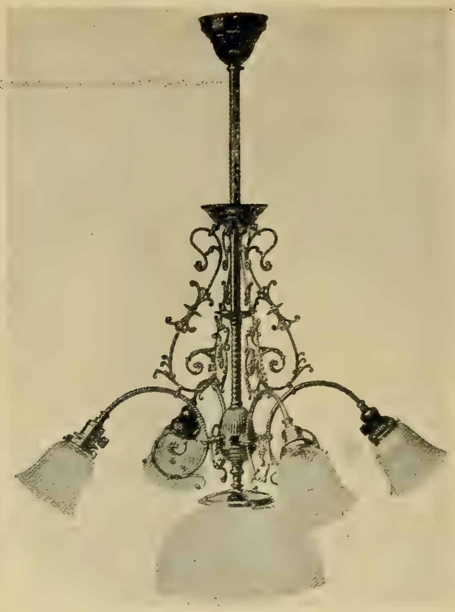


FIG. 8.

existence would be hard to find. One can imagine the designer (or the assembler) of the fixture as being distressed at the hiatus between the chord of the arm and the "upper-cut" feature of the end beneath and, not wishing to give a prospective buyer the chance to feel that he was not getting a full return for his investment inserted the wreath just because he happened to have it on hand.

Fig. 8 shows a tie which joins and supports the two arms, set in an inverted dinner-bell. The tie presents *renaissance* scrolls, the arms are plain drawn brass tubes, while the exact period of the dinner-bell receptacle is not known

FIG. 9.

Fig. 9 is a composition frequently seen in apartment houses, in parlors or dining-rooms, or almost any room where a general diffusion is attempted. While the illumination is effective, the piece offers such complete lack of motive and the movements are severally so feverish and hysterical that one cannot but wonder by what pressure the manufacturer was driven when he produced it.

Studies of Notable Instalations

The Factory of the Waltham Watch Co.

In many departments of the Waltham watch factory, the employees are engaged in very exacting work, as, of course, any watchmaker is obliged to be. However, when one considers that in the making of watches there are, for instance, screws, which, assembled in a pile in a pan, look like ordinary beach sand, one gets some idea of the fineness of the work, especially as these screws and other minute parts of the watch have to pass an inspection calling for as precise measurements as a one thousandth of a centimeter.

The lighting in the Waltham watch factory, as courteously explained by Mr. Everett W. Ela, the electrician for the company, is the development of years of close investigation and compliance with the desires of the employees, and it is interesting to note with what uniformity they work.

While it is at first apparently somewhat of an analogy to imagine such fine workmanship executed under the direct illumination of an incandescent lamp, with only an ordinary reflector to keep the rays out of the operators' eyes, it is, nevertheless, a fact that almost all of the illumination in this plant is provided by comparatively simple apparatus.

During the months when the demand for artificial illumination is greatest (at times the factory is obliged to run well into the night hours) the numerous buildings are fairly aglow. In the several buildings about 7,000 incandescent lamps provide illumination for some 4,600 employees. From the exterior one might get the impression that the several work-rooms were illuminated from floor to ceiling, but, as a matter of fact, there is very little general illumination in any of the rooms, except, of course, where office work or other ordinary services are required.

By both artificial and natural illumination the majority of the operators work directly facing the source of light. In the day time one sees them doing the finest work at benches which run along the sides of the buildings, the workers being not over three feet from the windows, with the various machines and parts used in assembling watches between them and the windows. This custom seems somewhat of an inversion of the ordinary laws of the proper use of light, but experience has convinced them that this is the best way to produce the results desired.

The peculiar character of the work necessitates the utmost attention to one of the elements of vision which

FIG. I.—DAYLIGHT ILLUMINATION.

is apt to be overlooked by illuminating engineers, and that is the effect of relief, or perspective. Those who are accustomed to use acute vision on flat surfaces only, as is the case in reading or writing, do not appreciate the importance of shadows and high lights as a necessity in bringing out the relief which plays such an essential part in viewing objects having solid dimensions.

Another feature of illumination to which attention is often directed, but which is of a peculiar application in the present instance, is what is known as direct, or "specular," reflection. The directions usually given are to avoid this as much as possible; but while such advice holds good in the case of flat surfaces, direct reflection is not only to be tolerated, but must be taken careful advantage of in the handling of small objects, as in the present case. The metal parts as they come from the machine have highly reflecting surfaces, and therefore must be seen largely by the light which is directly reflected from them. It is undoubtedly the necessity of promptly utilizing this direct reflection, in connection with the formation of the shadows in such a manner as to produce the greatest amount of relief, that has resulted in the peculiar use of light here exemplified, *i.e.*, of having the object directly between the source of light and the eye. It is not to be supposed that this arrangement has been the result of the theoretical observation just set forth, but rather that the practical conditions existing demonstrate the soundness of the explanation given, and, therefore, serve to point a moral as well as to adorn this tale.

The operator, when using artificial

FIG. 2.—THE USE OF DROP LIGHTS.

light, usually gets his head about as close to his machine as possible. The machine may be a lathe or some one of the innumerable devices for turning out fine pieces of work, but the general requirements are the same—to get a powerful light upon a comparatively small area; so long as a particular object on which the work is being done is in the full flood of the light there is entire satisfaction.

That this may be accomplished drop lights are suspended about the plant, the most of which are protected by ordinary conical tin reflectors, green on the outside and white on the inside. And when they are described as being "white on the inside" especial attention is called to the fact that they are white, which is, as every one who has given the subject any investigation knows, a condition not usually found in industrial plants.

Just how these employees have been brought to appreciate the necessity of keeping their reflectors in good condition could not be explained by Mr. Ela, or anyone else who was asked regarding this point; doubtless necessity has been in this instance the mother of invention, and the operators have learned from experience that if they do not keep their reflectors clean they do not get the illumination. It was observable that the incandescent globes were remarkably clean, but the examination of the plant having been made at the time of year when a good many of the lamps are not used at all, their condition was not a fair criterion of the care they might receive when they were in constant daily use. The reflectors which are used in this plant have a maximum diameter of about 8 inches, which seems to cover the average requirements. A considerably large number of shades in use are those of the porcelain type,

FIG. 3.—MAKING AN INSPECTION.

in appearance like inverted sugar bowls. It was stated as a fact, no explanation of which can be offered, that the women particularly prefer the porcelain type of shade for their work. It was left an open question whether this was due to the fact that the porcelain produces a certain general illumination which adds to the artistic and cheerful effect of the surroundings, or whether it was merely a matter of chance. However, there are a number of cases about the plant where the use of these porcelain reflectors is explained by the necessity for some general illumination, particularly where an operator is obliged to watch two or three machines; in watching these machines it is necessary for him to keep an eye upon the belt which runs the machine to detect anything that might go wrong and need prompt attention.

The porcelain shades are also used in many cases by the operator as a moderately illuminated background for detecting some particular defect in the work which has been done. The porcelain shades also give sufficient general illumination to make it quite necessary for the suspension of lamps for lighting the higher areas of the work-room.

In some cases a concentrator, or reflector, is used in the form of small cylindrical shades which can be so placed that the rays may be thrown upon the point where they are most needed.

The operators have devised an ingenious reflection of the rays of light which come either from the windows or from the electric lamps. This device is nothing more than the use of ordinary white calendered paper which is placed by the operator across his breast. Thus the illumination is gathered and projected against the "near" side of the machine or object which is being worked upon.

Another invention, evidently a child of necessity, for concentrating the light upon a small space, is shown in Fig. 3. This consists of a water bot-

tle similar to those used in druggists' windows, which serves the purpose of a large bull'e-eye lens. It doubtless, however, has the advantage of a solid glass lens of absorbing a far greater portion of the heat rays, since these rays in passing through the considerable volume of water would be largely absorbed. This effect might be considerably increased by dissolving alum in the water.

The lamps used throughout are 16 c.p., with the exception of one of the departments where powerful microscopes are employed; for the illumination of this particularly fine inspection 4 c. p. lamps serve better than the stronger ones. Cooper-Hewitt lamps are used satisfactorily in some of the store-rooms.

Considering the fineness of the work and the exacting strain under which the operators are almost constantly, it is remarkable that there is so little eye trouble among the employees. This fact is all the more astonishing because by far a majority of the employees are obliged to use small microscopes. These microscopes are set in a frame which is held in place over the left eye, the operator closing his right eye. The only explanation which can be offered for this absence of eye trouble is that one can get used to almost anything if given time enough.

Applicants for employment are invariably asked if they ever wear eyeglasses, and if they are found of deficient eyesight, they are not accepted. On one occasion it was noticed that a young lady who applied for work wore eyeglasses; upon being told that persons wearing glasses, for obvious reasons, were not preferred, she replied that she did not wear eyeglasses because she had to, but because they improved her appearance, and she begged to be allowed a trial on the ground that her improved appearance should not be allowed to militate against her.

FIG. 4.—LATHE LIGHTED BY REFLECTOR.

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The National Electrical Contractors' Convention

As we go to press the annual convention of the National Electric Contractors' Association is in progress in this city. If we had an inclination to be facetious we should state at the outset that the name of the association might properly be changed to the National Electrical Expanders' Association; for the work of its members literally measures the expansions and growth of the use of electricity in this country.

The position and general influence of trade associations is a subject upon which much of commercial and economical importance might be said. Commercial organization, as typified by the trade association, is the most characteristic feature of twentieth century American industrial conditions. It furnishes an antithesis to the old maxim that "competition is the life of business." As improvements in weapons of war, by their very increase in deadly effect, make wars less frequent, so it has been demonstrated that competition, carried to the limits made possible by modern commercial instrumentalities, may become an engine of destruction, rather than an element of life.

The old idea of trading which has come down from the immemorial past, was for the seller to secure the highest possible price from each individual customer, and for the customer to beat down the merchant to the lowest notch. A sale, or "trade," was merely a petty commercial duel. With the enormous growth of trade and the means of exchange of commodities this policy has been put aside along with the bow and arrow, and battle-axe of warfare. To be sure, competition is still a vital principle in commerce; but mere price cutting is not competition in the modern and best sense of the term. Profits are the sinews of war, without which all business must stop. Beyond a certain point, therefore, price cutting means invariably quality cutting, and this policy in the end results in such deterioration as to render the goods unsatisfactory, and in many cases almost worthless. The maintenance of such prices as will afford adequate returns for the investment of capital and brains, as, therefore, not only a legitimate, but a praiseworthy object; and this is one of the chief purposes of all

trade organizations. Admittedly, this principle may very easily lead to abuse in the way of trade restrictions and monopoly; but who will point out any virtue which is not subject to perversion and abuse? Where a reasonable price can be fixed and honestly maintained, it confines competition to its legitimate and wholesome field of excellence in quality, thus producing exactly the opposite effect of price competition; in other words, the sharper the competition the better the quality of goods or service which the consumer obtains. Of the effort of trade organizations to secure uniformity in prices there can be no reasonable objection, so long as this effort is made in a broad-minded and far-sighted" manner. We use the term "far-sighted" advisedly, for by the natural laws of trade, which most inevitably rule in the long run, the boosting of prices to an unnatural height is as sure to result in a disastrous reaction, as that a body thrown up will again return to the earth.

Besides the important question of prices, there are, of course, many other problems which can be dealt with to advantage by an organization of national scope. The general results sought are uniformity of material, workmanship, and general practice, as well as uniformity in price. In short, it is simply the standardization of trade, analogous to mechanical standardization, which has placed American manufacturers at the head of the world.

We therefore congratulate the National Electrical Contractors' Association upon the large and representative membership which it has obtained, and wish it the utmost success in the field which it has mapped out for its legitimate activities.

A Bi-Partisan View of Municipal Ownership

Some time ago the National Civic Federation appointed a committee of four to make a general investigation of the municipal ownership problem. This committee consisted of Walton Clarke, vice-president of the United Gas Improvement Company of Philadelphia; Charles L. Edgar, president of the Edison Electrical Illuminating Company of Boston; Professor Frank Parsons, president of the National Public Ownership League; and Edward W. Bemis, superintendent of the Cleveland Water Works, which are owned by the city. It was doubtless the intention to have the committee equally represented by those naturally favoring the two different views of municipal ownership; and the section of their report which has recently been made public may, therefore, properly be considered a bi-partisan view of the subject.

As might be expected, the views of the two different parties thus represented are widely divergent on most of the vital elements of the matter under investigation. Thus, Messrs. Clarke and Edgar prove by figures, to their own satisfaction at least, that municipal ownership has proven a losing proposition wherever tried. Answering this allegation, Professor Bemis asserts that "dollars and cents are not to be neglected, but life, liberty, virtue, and intelligence—the whole character product and social product of our institutions—are of greater moment than mere money product." Again, while the municipal ownership party admit that mismanagement and graft are often the distinguishing features of their system in actual practice, they reply that this is the direct result of a corrupt government which does not fairly represent the people.

Without wishing to enter into any academic discussion of the main proposition, which offers a field for mere argumentative gymnastics second only to the time-worn subject of protection vs. free trade, there is a point suggested by Professor Bemis's rather grandiloquent claim for "life, liberty, justice, virtue and intelligence," that has a direct bearing upon the subject of illuminating engineering.

Admitting for the sake of the argument that the virtues mentioned are of greater moment than the "money product," we fail to see any sufficient reason for assuming that municipal ownership offers any greater stimulus to the growth of these desirable qualities than does private or corporate ownership. In fact, the logic of conditions is against such an assumption.

Light is undoubtedly a good thing; indeed, so good that it has always been taken as the very symbol and emblem of mental and moral excellence. There is more than mere fancy in the statement that the more light a community uses in its streets, its public parks, its stores and business places, and its residences, the more enlightened it becomes in the moral sense of the term. Where light is furnished by the municipality, it is, of course, everyone's privilege to buy and use as much as he sees fit. There is, however, absolutely no inducement offered in any way to stimulate the use of light. The municipality is there, like Mahomet's mountain, but the mountain never goes to Mahomet, the consumer. On the other hand, with the privately owned lighting plant, the natural tendency, born of the desire to increase dividends to the highest possible point, is, figuratively speaking, for the mountain to go to Mahomet; in other words, for the producer to use every legitimate means to push the use of his product, light.

We fail to find anywhere in the report of the committee any claims that municipally lighted cities are the best lighted, and we do not believe that the facts would bear out any such assertion. On the contrary, there are plenty of towns in which private ownership prevails that can doubtless show a far greater and more intelligent use of illumination than prevails in municipally lighted cities.

Remove the incentive of personal gain, and the most invigorating element of progress is lost. The lack of this all-powerful leven is one of the most vulnerable points in the municipal ownership scheme. In fact, to state the main proposition, of which th efact mentioned is but a corollary, progress is always the result of individuality, and anything which tends to retard the growth or suppress the activity of the individual must invariably react injuriously upon general progress.

On general principles, therefore, we would place our wages on the privately owned lighting plant, which is under management of a progressive and alert individual, to win in the general line of usefulness and progress, against the plant operated by the salaried employees of a municipality, who have no further interest than to draw their salary—and keep on the right side of politics.

The Reading of Scientific Papers

The Electrical Times (London) notes the fact that The Illuminating Engineering Society is to hold its first annual convention in Boston, and after advising those interested to attend, gives the following very sensible comment on one of the reasons given in the Society's announcement why members should attend:

Do not fail to remember the benefit which you will get from hearing the authors read their own papers. So far the wording has kept more or less faithfully to the text, but at this point we must break off in order to enter a mild protest. Nobody ever yet obtained any benefit from hearing an author deliver his own paper. Papers on this side always seem to be better pronounced when read in the *Proceedings*. And no doubt it is just the same in Boston.

The practice of having papers printed and placed in the hands of the audience previous to their being read by the writers produces an anomalous condition of affairs which it is difficult to justify on any grounds. We can readily understand why one should follow the libretto of an opera while it is being performed, especially when, as is customary in grand opera, the singing is in a foreign tongue, since it is only in this way that one can know the meaning of what is being presented. But the oral presentation of a scientific paper can hardly be compared to the vocal efforts of an opera singer; in fact, it is difficult to conceive of any two vocal performances more widely different. The scientist who can express himself in clear and forcible written language is comparatively rare, and the one who can add to the written word by oral presentation is still rarer.

That papers are "better pronounced when read in the *Proceedings*" probably holds true to even a greater extent in this country than in England, or Europe. A technical society meeting or convention is not primarily an oratorical exhibition. It is doubtful if even the most accomplished speaker could add anything to the value of a scientific paper by oral delivery; and even if all the writers were accomplished orators, what is the justification for taking up the major part of the time of the meeting with a public reading of what is in printed form in the hands of the audience? The discussion of scientific papers at such meetings is often, and always ought to be, the most interesting and important part of the proceedings; but by reason of the reading of the papers the time for such discussion is generally so limited as to reduce the remarks to the mere passing of conventional compliments, or possibly to some bald dissention of opinion.

The writer of a scientific paper generally aims to give his information in the most condensed form possible, and therefore makes many statements upon which he would be glad of an opportunity to enlarge, or comment. If, instead of reading through his paper, he could take the time to draw attention to such statements as he deemed of particular importance, or make such comments as might help to elucidate the matters treated, there would be a positive gain to the audience, as well as to the printed proceedings.

Custom and precedent, however, have enormous inertia, and while it is readily apparent that the custom of reading papers would be "more honored in the breach than in the observance," it is likely to prevail for some time to come. As the Illuminating Engineering Society is probably the youngest of the tribe of scientific associations, why should it not declare its independence of unreasonable customs in the conduct of its meetings, as well as in practice of illumination. This waste of the precious time of the audience is a greater sin against the "efficiency" of the meeting than is the use of the densest opal glass in the diffusion of light. The Convention would furnish an excellent opportunity to introduce this much needed reform.

The International Acetylene Association Convention

The annual convention of the International Acetylene Association was held at the Riggs House, Washington, on July 15th, 16th and 17th. Beside a well-chosen program of papers bearing on the various technical and commercial phases of acetylene lighting, the subject of illuminating engineering was especially treated in a paper by Mr. V. R. Lansingh, on "The Lighting of the Home."

Perhaps no more impressive example of the magnitude of the lighting industry as a whole can be cited, than the present status of the acetylene industry. As a distinct branch of the lighting industry, it has in itself assumed large proportions, and is increasing at a rapid rate; and yet, so little of its destined field has it thus far covered as to be practically an unknown quantity to the vast majority of the users of light. In fact, there are millions of people who have never seen an acetylene flame, and to whom the word itself is without meaning. There are many living to-day who can well remember the time when whale oil was the most generally used light source for country homes, and the possible extinction of Jonah's companions was a really serious matter to contemplate; but before this calamity was realized, the oil fields of Pennsylvania were discovered.

That the supply of mineral oil is exhaustible there is no doubt; but, even while this contingency is hardly yet in sight, acetylene—the product of coal, or other form of carbon, lime and the electric furnace—is at hand, which offers a means of lighting the country home at least as much superior to mineral oil as the latter is to whale oil.

Byron's gruesome "Dream of Darkness" is, therefore, at most but a distorted vision of the invisibly remote future. Not darkness, but more and better light, is the evolutionary scheme of nature; and in the orderly course of this evolution acetylene will unquestionably acquire an important position in the field of domestic illumination.

Gas Illumination in Great Britain

The recent meeting of the Institution of Gas Engineers, in Dublin, was an event which, judged from the reports, may be considered as the English counterpart, in the general field of illumination, to the annual convention of the National Electric Light Association in this country. Gas apparently is still at the head as a light-source in England. Whether a more rigid governmental control, or that pugnacity with which John Bull is credited, or different economic conditions, are the cause, we cannot say, but it is clearly a fact that the combination of gas and electric companies which is the rule in America is an almost unknown condition in Great Britain. As a result, the competition between electric and gas lighting is maintained at the highest pitch, with the odds thus far apparently in favor of gas. Each party to the contest has its decks continually cleared for action, and is prepared at a moment's notice to train its heaviest guns on the enemy. Many of the questions that are still live issues there have long since been thrashed out in this country. Thus, at the meeting referred to, a gas engineer of international reputation treated at length the question of vitiation of the atmosphere by gas flames; and although his treatment of the subject was masterly and serious, it will doubtless surprise the electrical lighting fraternity in this country to learn that the incandescent electric lamp is really productive of a more "vicious" atmosphere than are gas

flames. It may be the American habit of taking chances, but we fancy that there is not one in ten thousand that would give the matter a second thought in either case.

The question of relative cost does not seem to have been fought to a finish there either. Here gas lighting has either meekly submitted, or been pushed into, the position of a second-class illuminant, good enough so far as actual light is concerned, but never available for use where the appearance of prosperity and "first-classness" is desired.

Engineer or Architect?

With the enormous increase in complexity of knowledge which has been the outcome of scientific progress, the term "engineering" has proportionately enlarged its scope and meaning, until, at the present time, it is made to cover almost every phase of human activity. It has even been seized upon by the professions entirely apart from material activity, the term "commercial engineer" furnishing an example.

Broadly speaking, an engineer is one who applies scientific knowledge to practical use.

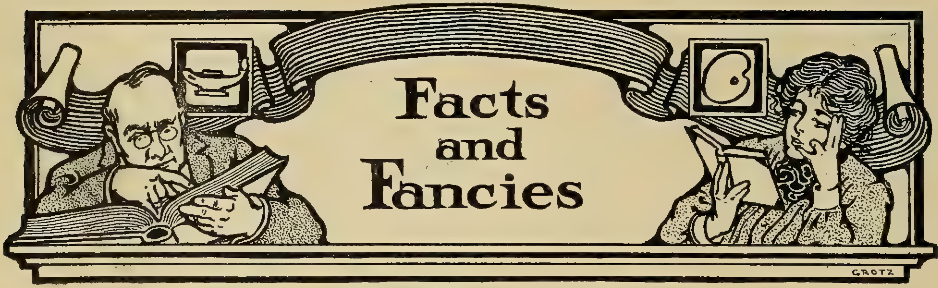
Keeping this definition in view, what is the distinction between the engineer and the architect? The design and construction of a modern building certainly involves the scientific application of physical facts and laws to a very large extent, and to just such an extent is the designer of the building an engineer. There is no essential difference between designing the steel framework for a building, and a steel structure to be used as a bridge; and the latter is clearly within the province of the civil engineer.

Similarly, the installation of an electric lighting plant is no less a mechanical and electrical engineering problem when put into a private building, than when put into a special building and called a "central station." The heating and ventilating, likewise, calls for purely engineering skill; and last, and too often least, the illumination is, or should be, in full charge of an illuminating engineer.

What then is left to the architect? Only the division of the space into the various rooms, and the decorative details of the structure. To these might be added the kind of material used, although the various engineers are quite as competent to specify in this particular.

The fact is that the conditions of modern civilization have entirely changed the status of the architect. Instead of being a creator of ideas and ideals, the architect of the present time is a mere copyist and compiler. The creative geniuses who worked out the architectural masterpieces of Greece and Rome, and the cathedrals of the middle ages, have no counterpart in this twentieth century. What passes for architecture at the present time is a mere conglomeration of the structural and ornamental forms developed in the periods mentioned.

Why then should the architect of the present time consider himself the master, and engineers of every description his subordinates? Instead of the architect employing engineers, as he may see fit, why should not the master engineer call in the architect to add such embellishments to his structure as may be consistent with its proper use, and the limits of cost? Such a division of labor and responsibility would certainly be much more in keeping with the actual conditions as they exist to-day, and would furthermore go far toward preventing the construction of that numerous class of buildings best described in Lawson's picturesque language as "pastry cook's nightmares in bronze and marble."



Display of Natural Gas at Sapulpa, Indian Territory

During the past year an immense supply of natural gas has been found in Indian Territory. New wells are being drilled and brought in almost daily. The greatest production is in the vicinity of the famous Glenn oil field. Within a radius of five miles there is a product of 500 million cubic feet of gas a day.

A committee from the Chicago Commercial Association made an extended trip through Oklahoma and Indian Territory in May of the present year. The Sapulpa Business Men's League arranged a unique exhibition with the object of impressing their visitors with the wonderful natural resources of the Territory. A line was connected with one of the strongest gas wells in the group and lighted at night. The accompanying illustration shows the flame. The pipe is a single section 8 inches in diameter. The actual pressure at the foot of the pipe was 585 lbs. per square inch, and the flame measured about 30 ft. in diameter.

The well from which this was fed flows 35 million cubic feet a day, and is undoubtedly one of the greatest natural gas wells in the world. The illumination from this great torch was visible for many miles.

A pipe line is nearly completed from these wells to Oklahoma City, a distance of 100 miles; and another line is projected to Kansas City, 400 miles distant. This practically unlimited supply of gas is offered for manufacturing purposes at a rate of 1½ cents per thousand feet, making it a cheaper fuel than free coal, on account of the cost of handling the latter.

W. H. Woodwell.

Uncle Sam makes Use of the Electric Sign

If there is any one question that employees in a post-office are obliged to answer oftener than any other, doubtless it is: "Where shall I mail this letter so that it will receive immediate attention?" There is much

less demand upon the time of the Boston post-office force than there used to be, in answering at least one of the diverting questions to which they have had to become inured, since the introduction of the illuminated sign as shown in the illustration herewith: "Boston and Stations, Quick Delivery. Post Letters Here."

The sign is large and the letters are plain, and it is difficult to conceive how even the most confirmed of Boston's star-gazers can miss these directions. So far as we know this sign is the only one of its kind installed in any of the post-offices of the country.

Railroad Night Signals

In a very interesting article, Mr. G. M. Stratton, discussing railway disasters at night, in the May *Century* says: The plan that I would propose would be to use throughout the twenty-four hours the kind of signal which is now employed only by day. * * * This could be accomplished simbly by making at night the vane of the semaphore luminous. As, in our cities, lights are arranged in lines and letters to catch the attention, so here the signal could become a fiery arm pointing outward or down or, if need be, midway between these directions, at will. Such a line of fire would be strikingly different from the usual lights of buildings or of streets. It would also, both in quality and in form stand out entirely distinct from all the colored lights whose use upon the railway it may, in the end, seem wise to continue for purposes other than the block signal. A continuous line of light, moreover, would be visible at a far greater distance than is the present single light. The glowing signal lights would best be white, and of course should not change in tint in order to convey their message. This would at once remove all need of discerning whether the line burned white or green or red, with all the risk which the distinction brings.

The mechanical difficulties of introducing the new form of signal would not be great. A row of half a dozen oil-lamps stretched along the front of the signal arm—lamps of the type at present used in the block system—could be counterpoised to prevent their interference with the proper action of the mechanism which controls the arm. Even with such lanterns the new system would have an immense superiority over the old, but no one should regard these weak lights as more than a makeshift; for what is urgently needed is something that will penetrate the smoke and mist and storm. There would be many advantages in using incandescent electric lights throughout the large area where a suitable current is now available—an area rapidly increasing, and doubtless destined soon to cover nearly our whole land. The objection to the use of electric lights, that they are liable suddenly to fail if for any reason the current is interrupted, would not be serious where electricity is also the motive power of the trains; for, should the current cease, and the signal lights go out, the train would at the same time soon be brought to a stop, and there would be no immediate danger from the interruption. But on roads where electricity is not the motive power, the best illuminant for the new signal would perhaps be gas stored under pressure in tanks—gas such as is used in many of our railway cars or in the gas buoys set along our shores by the government. Since these buoys burn untended for months in storm or calm, it would seem that such a light might well be adapted to illuminate the semaphore arm. For if a line of oil lamps were used, the temptation would be strong to economize in weight and consequently in oil capacity, and thus to have only a moderate brilliancy where a powerful light is needed.

Windows at Night

"I used to think the money spent for light in show windows from closing time till morning was wasted," said a Fifth avenue merchant to a New York *Sun* man; "but I have changed my mind about it, and now I keep my windows lighted until 3 A. M. every night but Sunday. I took the trouble to make some investigations as to the value of shop windows before I changed my method. I found that in daytime, when the streets are filled, no one has time for more than a glance at the displays. But at night, and particularly late at night, while there are fewer people out, they are not in a hurry and many of them stop to examine critically the goods shown. I have frequently seen men and women, too, who were window shopping before my place at night, inside buying the things the next day. Many people in New York keep themselves posted on fashions and on what is to be had in the stores by 'window shopping.'"

Niagara Illuminated

The contract has been closed for the night illumination of Niagara Falls, and the proposed plan for lighting the mighty torrent will be the greatest feat ever conceived in electrical illumination.

The Falls will be illuminated for the first time August 15, and the General Electric Company has charge of the work. The illuminating scheme calls for nearly fifty large searchlights, several of them the largest of their kind and capable of throwing a beam of light a hundred miles, and the new color scintillator, a late invention. The projectors will be located below the Falls in two batteries, one at the water's edge and the other on the high ground of the Canadian side. Every inch of the two falls will be under light.

The new color scintillator is an attachment fitted to the searchlights by which the beams of light can be made any color at will. Thus the mist and water, bathed in all the colors of the rainbow, will surpass anything in spectacular effect save the great Northern Lights.

The proposition is to illuminate Niagara on a scale in keeping with the surroundings. It is said by the illuminating experts that the rays of colored lights when flashed in the air will be visible at Rochester and Toronto.—Exchange.

Fatal Bravado

To be included among the foolish ones who trifle with lights, are those individuals we occasionally hear of who attempt to ignite cigars from arc lamps in the street. One such instance of folly took place in the case of Joseph Goodon, Ogdensburg, N. Y., on April 30th. With several companions he was returning from a dance, when in a spirit of bravado he lowered one of the big electric street lamps and placed his cigar against a carbon. Killed of course. Such cases can end only in that way, and it's not so much of a reflection on electricity, either.—*Acetylene Journal.*

New Railroad Signal Light

The New Haven Railroad has just added one more color to its signal system by the adoption of the purple light in conjunction with the red, yellow, and green lights already in use. The new color replaces the red light, which formerly indicated the position of the cross-over switches, marked by dwarf signals. These signals are placed close to the ground in order that the engineer may not see them until he is within a short distance.

Electric Light Least Harmful

A Russian medical man has decided that electric light is least injurious to the eyes. He says that the oftener the lids are closed the greater the fatigue and consequent injury. By experiments he finds that the lids would close in candle light 6.3 times per minute; gas, 2.8 times; sun, 2.2 times; electric light, 1.8 times.—*Electric City.*

Unbuttons the Light

"I know where the 'lectricity that lights our house comes from," said little Edna. "Where does it come from?" queried her small brother. "From the wall," replied Edna. "When mamma wants a light she unbuttons it."—*Electric City.*

Watt a Question

Teacher: Our ancestors lived in the Stone Age. What age are we living in?

Scholar (promptly): The Volt-age.—*Electric Wave.*

Commercial Engineering of Illumination

Illuminating Engineering Bulletins of the National Electric Lamp Association

The Engineering Department of the National Electric Lamp Association has recently issued a number of Bulletins of usefulness to those interested in questions of illumination. The department has entered on a new field of Bulletin work. It is the intention to improve illumination by aiding all who are confronted with problems of illumination with incandescent lamps. To this end copies of the Bulletins have been mailed to over 17,000 architects, building contractors, illuminating engineers, electrical engineers, college professors and students, mechanical engineers, civil engineers, members of electrical associations, members of electrical societies, etc.

Bulletins No. 1 and No. 2 give a brief description of the National Electric Lamp Association and the work of the Engineering Department.

Bulletins No. 3 and No. 4 treat of the Gem metallized filament lamps. Cuts of the lamps with various Holophane reflectors are given, together with the vertical distribution curves of the lamps and units. There are tables showing the sizes and dimensions of the lamps, operation of the lamps, illumination data and cost of operation. The cost tables should be noted by all since they show the actual cost of operating lamps on various costs of power.

Bulletin No. 5 gives a description of the Tantalum filament lamp, its operation, light distribution, light quality, etc. Tables showing the comparative cost of operating Carbon, Gem metallized and Tantalum filament lamps, show the necessity of installing Tantalum lamps where the cost of power is high. The Bulletin is of extreme interest to all who are seeking relief from overloaded generating apparatus, peak loads or fluctuating voltage.

Bulletins No. 6 and 6-A describe the new form of Tungsten lamps. These lamps have but recently been developed and for lighting of streets afford a ready and effective means which in economy and adaptability exceeds any other system. The 40 and 50 c.p. street series type operate on direct current or alternating current of any periodicity. The energy consumed is at the rate of one and one-third watts per candle while the life is stated to be 1,000 hours.

Bulletin No. 7 is entitled "Data on Illumination." The Bulletin gives a number of points to be considered in

designing illumination, also methods of illumination and measurement of light. Vertical distribution curves of the various lamps are given, together with cuts of the lamps themselves. The Bulletin contains many interesting and useful tables showing intensities of various light sources, color of common illuminants, effect of various colored lights on various colors, required illumination for various classes of service and increase of illumination for various colored walls. Table No. 4 is of special value to all those figuring illumination. This table shows the intensity of illumination in foot candles, produced at various points in horizontal planes by a light source of one candle power. It also gives the angle made by the light ray and a line perpendicular to the horizontal plane. By the use of this table a method of figuring illumination is given which will save illuminating engineers an immense amount of time. Tables are figured for several of the more recent types of lamps, showing the illumination given by the lamps in various horizontal planes. In addition to the above, wiring tables and formula for the computation of lighting circuits are given for the use of architects and contractors, who are often required to lay out wiring circuits. The Bulletin is, in reality, a handbook of illumination and treats the subject in such a clear and concise manner that it is sure to be popular not only with the engineer but also with the layman.

All who have not done so should send their names to the Engineering Department, 4411 Hough Avenue, Cleveland, Ohio, so that they may receive copies of further Bulletins issued by the Engineering Department.

The Illumination of the Marshall Field & Co. Stores in Chicago

While it would be odious to make comparison of the Marshall Field stores with those of any others of a similar class there can be no question that there are no others on the American continent, and but few in the world that are more widely known. The method of illumination used, therefore, becomes of special interest to illuminating engineers as well as to merchants in general. The interest in any system adopted is further enhanced by the fact that the electrical engineer in charge is at the same time a thoroughly competent illuminating engineer, and that before making a final decision he has spent several years' time in studying the conditions, and in making practical tests of various systems. As a result of his investigation he has finally decided upon the use of Nernst lamps exclusively.

The thirteen floors to be lighted vary in ceiling height from 14 to 19½ feet. Two and three-glower lamps suspended on specially designed chain pendants, hanging from three to five feet from the ceiling according to height, will be used. The fixtures are particularly appropriate in design and the lighting units will add materially to the appearance of the store.

Incandescent lamps to the number of more than 40,000, in low hanging fixtures, were formerly used. The new lighting system will be installed under the direction of Mr. F. J. Pearson, Electrical Engineer for Marshall Field & Company.

A more detailed and technical description will appear in our pages at a subsequent date.

Correspondence

From Our London Correspondent

PRES. HUNT'S ADDRESS TO THE INSTITUTION OF GAS ENGINEER.

We must again call attention to the proceedings at the recent conference, held in Dublin, of the members of the Institution of Gas Engineers. The president, Mr. Charles Hunt, delivered a very able and practical address; it was, of course, prepared particularly for those engaged in the production of gas, rather than for those who "engineer illumination." He said, "The general effect of electric lighting has been to educate the public taste to a more liberal standard of illumination and that alone has tended greatly to the benefit of gas undertakings." Upon the question of the standard of illuminating power, Mr. Hunt expresses the opinion that, "there is no such thing as finality in the matter, so long as advantage is to be gained by actually withdrawing illuminating properties from the gas, and relying upon the calorific rather than the illuminating power."

It is natural to look for a bias in favor of gas when a gas engine draws attention to the electric light; still, Mr. Hunt was good enough to add that the competition between the two illuminants, so far as private lighting goes, is a fair and open one; with public lighting it is a different matter, he says, although, "the superiority of incandescent gas is patent to everyone, it not infrequently happens that electricity is adapted at considerable additional cost to the rate payers, simply because the local authorities possess electricity works and desire to support their own establishment."

It is an old adage that "figures can be made to prove anything." No doubt there are instances both in London and in provincial cities where the cost of public lighting with electricity is out of all character.

Here are a few such instances:

	Cost per Mile.	
Name of Town.	Electricity.	Incandescent Gas.
Bexhill	$ 677.00	$336.00
Hastings	3,360.00	384.00
Bristol	2,213.00	360.00
Cheltenham	2,937.00	278.40
Croydan	2,385.00	264.00

Mr. Hunt said a good deal more about public street lighting. It had, however, but little interest to others than those in control of gas production.

MR. GOODENOUGH'S PAPER.

The paper which, much more directly, was of interest to illuminating engineers, was that read by Mr. F. W. Goodenough, chief inspector of the Gas Light & Coke Company, London. We have referred to his work in a previous article. Some idea of the magnitude of the business may be gathered from the fact that the company have 75 districts containing about 225,000 customers supplied through ordinary meters, and 260,000 supplied through prepayment meters.

On this side, comparatively few gas companies carry an internal gas fitting business, but Mr. Goodenough is pushing forward the control of the consumers' fittings, and practically all cookers, fires, etc., are now fixed with the company's servants.

MAINTENANCE OF MANTLES.

Another, and, of course, comparatively new department, is that devoted to the "maintenance of mantles." The Gas Light Company are now maintaining about 200,000 burners, but the consumer does not take kindly to the business. He is, unfortunately, suspicious that the company are "having him"; that by some unseen means, the fact of their servants keeping his burners and mantles in good working order, must be paid for by their making him burn more gas. Those who are "in the know," are perfectly well aware that if the consumer were to go his own sweet will, as he far too often does, he would burn considerably more gas and get much less light. The gas producer does not want that class of customers; is always grumbling, is a bad advertisement for the use of gas, and brings it into disrepute.

UNCOLLODIONIZED MANTLES.

The use of uncollodionized mantles is rapidly being advanced. So far, the Gas Company are burning off and using some 250,000 such mantles a year. The use of them is of material assistance when the gas companies undertake the maintenance of burners and mantles.

MR. TOOM'S PAPER.

Another reader, Mr. John G. Tooms, in the course of a paper upon the development of consumption, said that in a public institution, in Waterford, Ireland, he had fixed No. 0 and No. 2 Welsbach, Kern's, in lieu of flat-flame burners with the result that the half year's gas account was reduced from $561.60 to $206.40. This latter figure included maintenance and the institution, was, it goes without saying, much better lighted.

The average per cent. of the gas used for lighting in Waterford, is by means of incandescent burners. In all, some 16,327 gas burners are fixed in the city, and of these, 10,263 are incandescent and 6,064 flat-flame burners. These latter burners represent but a small consumption of gas, because they are almost all in small shops and cottages.

MR. SEARLE'S PAPER.

Mr. Robert M. Searle, of Rochester, N. Y., took part in the discussion upon both papers and said he had to make confession of being a dual manager, a manager of both electric lighting and gas works. His first experience was in the retort house, and it was many years before he realized that ten times more profit could be made in the commercial department.

Mr. Searle's remarks upon the "commercial end" were much appreciated; still, he was good enough to say that Mr. Goodenough's and Mr. Toom's papers had "enthused" him. He told the members that "They figured it out in Rochester that they could increase the consumption of the old consumer by 40 cents on every dollar of income. They had a history card of every house which provided a record of everything that was in the house. Each canvasser had 10,000 people to handle, and it was his duty to get everything else in the house, and if he did not, these cards were taken out every morning until each particular property was "cleaned out." Since the first of January, under this system, at Rochester, they had succeeded in placing 2,000 gas ranges and 20,000 gas consuming fixtures.

Mr. Searle also spoke of a combined company who were pushing a combi-

nation of electric light with gas in consumers' houses. They found it reduced gas consumption, slightly but the income increased 65 per cent. from a particular property because they used both electricity and gas in a few months.

Mr. Searle, in addition to his kindly help in the discussion of the papers, contributed one himself on "High Pressure Distribution of Gas." The subject is one of permanent interest to gas engineers and has a considerable bearing upon illumination.

DISCUSSION OF MR. COPP'S PAPER.

Mr. W. R. Herring, of Edinburgh, said that he had found the best efficiency in using inverted gas burners was got with gas at from 20 to 30 tenths pressure. He thought that when the pressure varied much, particularly at night, with public lighting, and when the pressure was reduced below 15 tenths, the combustion was incomplete and there was liable to be a smoky flame and a deposit of carbon on the burner. During the night they supplied 1¾ cubic feet of gas per hour to each burner, but in the lighting hours, as generally required, the burners took 2¾ cubic feet hourly, so bringing up the average consumption to 2¼ feet per burner. Of the two types of burners used, they obtained 30 candles and 34 candles per cubic foot of gas, respectively, with gas of an illuminating value of 20 candles.

Investigations have satisfied Mr. Herring that with these two burners, the best results are obtained with preheated air, supplied unvitiated by the products of combustion. The air supplied under these conditions is responsible for fully 25 per cent. of increased efficiency.

Mr. Walter Grafton, a specialist in burner construction, and one of the staff at the Beckton Station of the Gas Light & Coke Company, drew attention to Mr. Copp's reference to the composition of gas as affecting results. He said that it was not only the burner, but was a question of suiting the injected action to the composition of the gas. With regard to the mantle, he said the finer the mesh the better the result, and the greater would be the cost of maintenance. This cost should not be more than six cents per burner per annum. Mr. Grafton said he had burners "going night and day for two years."

We shall be pardoned in dealing at such length with the conference of gas engineers, but the matters we have briefly touched upon are such we venture to turn to as will be of interest to the readers of THE ILLUMINATING ENGINEER. The institution of gas engineers was formed in 1864, and was then called the British Association of Gas Managers. It is the largest, and, we think, the oldest society of gas officials in the world, so we offer no apology for occupying space in making comments upon its deliberations.

New Books

We have on our table several interesting books for review. At this time a "History of the Introduction of Gas Lighting" is of national importance. Such a book is before us written by Mr. Charles Hunt, whose able work we have referred to before. Another valuable book is written by Mr. Walter Hole, superintendent of the City of Leeds Gas Distributing Department, and the Distribution of Gas. The author deals in a most exhaustive manner with all apparatus, methods of supply, meters, governors, fittings, etc., up to and including the consumers' burners and covers.

The Illuminating Engineering Society

Meeting of the New York Section, May 10th

Color Values of Artificial Lamps*

By G. H. Stickney.

Artificial lights differ from daylight more or less in their composition—that is, in the proportion of different colors they contain; for instance, a light may have too much red or the violet waves may not be present in sufficient quantity. On the other hand, certain artificial lights emit an excess of violet and others are exceedingly rich in yellow or green.

In all cases where the so-called "daylight balance" is not maintained the light is no longer white but the excess or absence of some particular color is noticeable not only in the color effect but in a general lack of clearness.

It is generally known that the mercury arc does not contain any appreciable amount of red. A piece of material which would reflect red rays under a white light would appear black by total absorption under the mercury light.

Yellow materials displayed in the light of the Nernst or incandescent lamps become pronounced and slight differences in pale yellow can hardly be distinguished from white as the latter is capable of reradiating almost as much yellow light as the former. The same relation exists between green and white exhibited under the Welsbach gas or vapor hydrocarbon lights.

Direct and alternating current enclosed arcs, particularly the latter, emit an excessive amount of violet light when equipped with clear globes, so that blue and violet materials exhibited under this light are stronger than they would be in average daylight. The violet light is emitted by the arc itself, while the white light, which forms 75 to 80 per cent of the total luminous flux, is emitted directly by the crater.

Before the enclosed arc is suitable for accurate color selection, the excess violet light must be disposed of. This can be accomplished by using opal enclosing globes and still further improvement may be made by the use of suitable reflectors coated with enamel, having a high selective absorption for violet waves. We therefore have at our disposal means of purifying the arc light to a high degree so that colored goods can be displayed with practically daylight effect.

INSTRUMENTS FOR COLOR COMPARISON.

In order to bring out prominently the superiority of the arc lamp for color matching and selection, three instruments have been devised, namely, the "lumichromoscope," "photochromoscope" and "parachromoscope."

With any of these instruments a prospective buyer may compare the effects of various lights on colored fabrics and such apparatus should be of value in convincing customers that a white light is indispensable for many classes of mercantile illumination.

The lumichromoscope is probably the most practical instrument for general demonstration purposes. This apparatus is arranged so that four lights, say of the arc, Welsbach, Nernst and incandescent lamps, fall simultaneously on the material to be examined. Each light forms a patch two and one-half inches square with a black border separating each square so as to reduce simultaneous contrast or gradation.

The lamps are arranged at such a distance that the relative intensity of the different lights falling on the material is the same, thus eliminating tint and shade effects, which take place when the intensities are of unequal strength.

* Condensed from an address delivered before the New York section, May 10. A number of experiments were shown, illustrating the characteristics of various lamps.

Orange	rays	falling	on	white	make	it	appear	orange.
"	"	"	"	red	"	"	"	reddish-orange.
"	"	"	"	orange	"	"	"	deeper-orange
"	"	"	"	yellow	"	"	"	orange-yellow.
"	"	"	"	green	"	"	"	dark-yellow-green.
"	"	"	"	blue	"	"	"	dark-reddish-gray
"	"	"	"	violet	"	"	"	dark-purplish-gray.
"	"	"	"	black	"	"	"	brownish-black.
Red	"	"	"	white	"	"	"	red.
"	"	"	"	red	"	"	"	deeper-red.
"	"	"	"	orange	"	"	"	orange-red.
"	"	"	"	yellow	"	"	"	orange.
"	"	"	"	green	"	"	"	yellowish-gray.
"	"	"	"	blue	"	"	"	violet.
"	"	"	"	violet	"	"	"	purple.
"	"	"	"	black	"	"	"	rusty-black.
Yellow	"	"	"	white	"	"	"	yellow.
"	"	"	"	red	"	"	"	orange-brown.
"	"	"	"	orange	"	"	"	orange-yellow.
"	"	"	"	yellow	"	"	"	deeper-yellow.
"	"	"	"	green	"	"	"	yellowish-green.
"	"	"	"	blue	"	"	"	slaty-gray.
"	"	"	"	violet	"	"	"	purplish-gray.
"	"	"	"	black	"	"	"	olive-black.
Green	"	"	"	white	"	"	"	green.
"	"	"	"	red	"	"	"	yellowish-brown.
"	"	"	"	orange	"	"	"	grayish-leaf-green.
"	"	"	"	yellow	"	"	"	yellowish-green.
"	"	"	"	green	"	"	"	deeper-green.
"	"	"	"	blue	"	"	"	bluish-green.
"	"	"	"	violet	"	"	"	bluish-gray.
"	"	"	"	black	"	"	"	dark-greenish-gray.
Blue	"	"	"	white	"	"	"	blue.
"	"	"	"	red	"	"	"	purple.
"	"	"	"	orange	"	"	"	plum brown.
"	"	"	"	yellow	"	"	"	yellowish-gray.
"	"	"	"	green	"	"	"	bluish-green.
"	"	"	"	blue	"	"	"	deeper-blue.
"	"	"	"	violet	"	"	"	deep bluish-violet.
"	"	"	"	black	"	"	"	bluish-black.
Violet	"	"	"	white	"	"	"	violet.
"	"	"	"	red	"	"	"	purple.
"	"	"	"	orange	"	"	"	reddish-gray.
"	"	"	"	yellow	"	"	"	purplish-gray.
"	"	"	"	green	"	"	"	bluish-gray.
"	"	"	"	blue	"	"	"	bluish-violet.
"	"	"	"	violet	"	"	"	deeper-violet.
"	"	"	"	black	"	"	"	violet-black.

PREDOMINATING COLOR OF ARTIFICIAL LIGHTS.

Lamp.	Color.
Enclosed arc—clear globes....	bluish-white.
Enclosed arc—opal globe and selective diffuser	white.
3¼ amp., 140 volt d.c. enc. arc,	violet (beyond color correction).
Nernst lamp—new glower,	pale lemon-yellow.
Nernst lamp—seasoned glower,	deep lemon-yellow.
Incandescent—new	yellow.
Incandescent—seasoned,	pale orange-yellow.
Welsbach and vapor hydrocarbon—new	greenish-white.
Welsbach and vapor hydrocarbon—seasoned	greenish-yellow.
Ordinary gas flame........	reddish-yellow.
Mercury arc lamp............	blue-green.

The preceding tabulations give the effect of colored lights on aniline dyed materials and the predominating color of artificial lights in common use.

THE EFFECT OF COLORED LIGHTS ON ANILINE DYED MATERIALS.

From tests by M. Chevreul at the Gobelin Tapestry Works. With Additions by W. D'A. Ryan.

INTRINSIC BRILLIANCY AND DISTRIBUTION.

It is generally admitted that the arc lamp is the most efficient source of artificial illumination, but, unfortunately, high efficiency generally goes hand in hand with high intrinsic brilliancy and the distribution of the arc, in common with other artificial light sources, is not by any means ideal for general interior illumination.

This objection is partly met by the use of low power lamps, taking about 300 watts. These are especially useful in low studded rooms or where there are many light intercepting objects in the area to be illuminated.

While the small units provide, possibly, a more uniform distribution, they are, unfortunately associated with a considerable decrease in efficiency as compared with 500 to 7.0 watt lamps commonly used, to say nothing of the further disadvantage of a larger number of units to install and maintain.

With the elements of intrinsic brilliancy and distribution once properly disposed of, less weight will be given to the life of carbons and greater attention will be paid to improving the efficiency and stability of the arc by raising the current to the highest point consistent with a reasonable globe life.

There appears to be nothing on the horizon at the present time to rival the enclosed arc lamp for interior mercantile lighting, particularly where color values are important.

While the tantalum and tungsten lamps represent a marked improvement in efficiency for lamps of the incandescent class, the color has not been sufficiently changed to warrant classifying them as white lights. The magnetite and flaming arcs represent a class of efficient illuminants which unfortunately in the present forms, are not particularly adapted to general interior illumination and therefore need not be considered in this instance.

The most promising immediate improvement in general lighting is through the use of high current enclosed arcs with proper diffusing devices.

DISCUSSION.

The Chairman (*L. B. Marks*).—I call the attention of those members, who may not have seen it, to an article in the April number of the *Century Magazine* by Dr. E. A. Ayres, which gives a very able and interesting illustrated discussion of the subject of the address. It is well worth reading.

Among others we are favored this evening with the presence of a distinguished representative of the English section of illuminating engineers, Mr. Leon Gaster.

Leon Gaster.—The question of the influence of color upon sight is one which has received very little attention in England, in spite of literature which has come across the water to us, because the illuminants which vary much in color have been very few, until quite recently. What the influence of the different colored light sources, which have been recently introduced has been upon the sight, will be, few have been able as yet to determine, as there has not been a great deal of information upon the subject. I know that the defect of color blindness transmits itself from generation to generation. Professor Starling, of the Royal Institution of London, recently lectured on the question of "Color in Sight," and showed the remarkable fact that color blindness is transmitted only to the male descendants. If a man is color blind and he has a son, the son will also be color blind, but if he has a daughter she will not be color blind; yet if the daughter marries, her male descendants will be color blind, although she may not be. That is a remarkable fact. I am given to understand that Professor Duma reported before the Royal Institution a hundred years ago on some color effects upon sight. The result of his lecture led to the investigation of the question of color blindness, and the history of families was traced, and it was found that over a period of a hundred years all the direct male descendants and the sons of the daughters were color blind. Now that is a very serious thing, and if we can help to avoid such color blindness by having these people work under certain colors, that is a very important thing to do.

In the demonstration given by Mr. Stickney, when the comparisons were made between the different lights, I noticed that the enclosed arc with the diffuser reflector showed white. I should like to know why it was white, because that might aid us in educating the architects to use this light when they desire a purely white light. I noticed further that the intensity of illumi-

nation is much higher in this country than we are accustomed to in England. I do not know whether we live in darkness over there, or whether you live in brightness and luxury here, but your foot-candle standards of two and five-tenths and three startled me. In England our foot-candle standard is only one and eight-tenths.

D. McFarlan Moore.—The three most important facts in connection with any illuminant are efficiency, color and steadiness. A few years ago there was practically no way of changing the colors of the various forms of lamps, that is, the candle had its color perforce: such a thing as modifying it was not dreamed of. The oil lamp had its color; the open burner gas flame its color, the incandescent lamp its color, and the arc lamp its color. Then gradually attempts were made to increase the flexibility of our systems of illumination so far as color was concerned, and, as we all know, the successful experiments in connection with the Welsbach lamp, form probably the most prominent example. At the present time there are only two ways widely in use of varying the color: that is, if a person wishes to have a light of a different color, there are two main ways of getting it. One way is to get another light source, and the other way is to use a diffusion globe of some kind, which in any instance is extremely unscientific and inefficient. Some of the most recent advances in this line are connected with the flaming arc lamp. There we have an instance where the first step, at least, was taken toward scientifically controlling the color value. I refer to placing different chemicals in the carbon and thereby obtaining a color which can, to a very great extent, be determined previously. But still it by no means can be said that by means of the flaming arc lamp the color factor is under perfect control. However, it is possible now to have the color value under perfect control, and this is obtained by utilizing a vacuum tube, and by changing the various gases used in the tube to change the color. This has many advantages, and from a scientific standpoint it cannot be criticized as can the other methods which have been used. For example, if you use a properly regulated vacuum tube and feed it with air only, a pink light results; if you feed it with nitrogen a yellow light results, and such a light can be used for a great many purposes: in fact, its range of usefulness so far as the color is concerned, is about the same as that of the ordinary incandescent lamp and therefore can be used by florists or by clothing merchants, and the distortion is not any worse than that of the ordinary incandescent lamp. However, it is not by any means claimed that when a tube is fed nitrogen, that the color is at all near daylight: it is simply a color which appears about the same as that produced by the ordinary incandescent lamp. Due to the enormous radiating surfaces of the tube, the color in daytime looks considerably redder than that of the incandescent lamp because the lamp is extremely small as compared with the tube. When such a tube is fed with carbon dioxide at a definite pressure, and at a definite intensity, a light is obtained that undoubtedly is closer to average daylight color values than any light which has ever been produced before, and we can almost say that it is entirely satisfactory. For instance, experts in matching colors in the largest dye works of this country, men who have tried all other forms of light and found them not at all suitable for their uses, have matched their colors under a vacuum tube supplied with carbon dioxide and have found after months of practical use that they could not detect any difference between the most delicate lavender shades, when they are matched at night time under the tube and in daytime by daylight, not direct sunlight.

Such a tube ought to be used as a standard of light. We are here to-night in an endeavor to reduce to an exact science the subject of artificial illumination, one branch of which has to do with color values. The first step in reducing to a scientific basis any subject is to eliminate variables and decide on constants. This society should unite with other scientific societies and decide on standard specifications for accurately reproducing the pure white light due to carbon dioxide in a vacuum tube. Then we could express other forms of light in terms of it. For example, if it was claimed that a certain light had a pink color, it would mean that it was pink as compared with a standard carbon dioxide light. The next thought is that the standard of light, as regards color values, ought to be the final form of light to use as the standard for photometric measurements, which are now influenced by the kind and quality of the light used as the standard.

The efficiency of any light source is largely dependent on its color. This is due to the fact that the yellow rays have a maximum effect upon our eyes, and therefore a light which predominates in yellow

or green has a better efficiency than one with a larger number of prominent colors.

Measurements of illumination are extremely complicated and will always remain complicated since they depend on the eye. The sphere of activity for illuminating engineers, as this matter of color values becomes more and more refined, will become larger and larger. It is not a subject that will ever be reduced to simple mathematical terms. We can determine with great exactness the efficiency of a motor, but if we take the same amount of electrical energy and endeavor to determine the efficiency of the transformation when it is turned into useful illumination, immediately not only does the problem become complicated but the objects illuminated also become of prime importance.

The history of colors of light as depicted by the various forms of light is extremely interesting, and the main point to be noticed is that as time has advanced the various forms of light are extremely interesting, and the main point to be noticed is that as time has advanced the various forms of light have become whiter. The flaming torches of the Romans were extremely red. Then came the candle, the oil lamp, the gas flame, the incandescent lamp and the arc lamp. We all remember how the arc lamp was considered a ghostly white light, and there was a great deal of objection to it on that score. But artificial illumination has progressed until we have come to the vacuum tube, which, when supplied with carbon dioxide, was criticized as being a bluish white by those who did not realize that daylight is a bluish white. Some of the best experts on illumination have declared, even in recent years, that a white light at night time was unnatural. Such statements are dying out and we will gradually hear less and less of them, until artificial daylight all night will be the universal demand.

Chairman Marks.—Perhaps Mr. G. L. Hunter can tell us something about the color values of light as applied to decorations, wall tints, etc.

G. L. Hunter.—The efficiency of the different colors of lights in illumination varies greatly with the color of the walls. When the incandescent bulb is used, a slight tint of orange on the walls renders the room more cheerful and brighter. A room with a light green paper is distinctly better lighted by the Welsbach lamp than a room with paper slightly orange. In practical illumination the color of the light as compared with the color of the wall, must be taken into consideration; the color of the wall is of the greatest importance. You may have all the efficiency in the light that is possible, but unless you carefully consider the various furnishings you do not get the effect that is desired. For instance, in a room where the upholsterings are of green and the walls of orange, the use of an orange light may actually reverse the contrast effects obtained with a green light. The orange light makes the furniture stand out, while the walls recede; with the green light the walls come toward you, and the furniture becomes less prominent.

Dr. H. H. Seabrook.—Mr. Stickney did not make entirely clear the question of the spectral colors in vision and pigment colors as applied to decoration. Most eyes see six primary colors; some of us are favored by seeing seven. From the three fundamental pigment colors, red, green, and violet, all other colors may be formed by mixing. Color blindness, absolute color blindness, a pathological condition, cannot be helped. There is really no need of trying to educate people to see correctly who have real color blindness. There is a lack of knowledge of color affecting about five times as many men as women, and that is a condition which can be cured by education. With mixed colors, spectral colors and pigments follow a different law. The pigments, yellow and blue, will make green when mixed, because the yellow and blue neutralize, making gray, leaving the green to show; whereas in the spectrum yellow and blue, when mixed, are complementary colors and form gray. Upon this the whole mathematical doctrine of the neutralization of colors by artificial light rests.

The question which Mr. Stickney brought out is not entirely that of matching colors in one special light; the point which might interest some more, is the change of colors in different lights: how to know what the color would be in daylight or some artificial light. Meyer in 1879 gave a color analysis of the three light sources, kerosene, gas and electric light; the constant was taken as 1, for yellow, expressing equal luminosity (these three lights are warm, with an excess of red); electric 2, kerosene 3, gas 4. For green these lights show respectively, 1, .6, .4; for blue .8, .2, .2; for violet .1, .1, .1. If you will remember that complementary colors are neutralized by an excess of a given color in artificial light and corresponding colors intensified, you

have what might be called the law of colors by artificial light. This law has been worked into exact mathematical formula by Dr. Franz Becker in an article entitled "Untersuchungen über den Farbensinn bei künstlicher Beleuchtung" to be found in No. 3 of Vol. LIX. of the *Archiv für Ophthalmologie.*

There is, however, a more important question than color vision in choosing artificial light. In 1845 Brucke began the study of the effects of ultra-violet rays upon the eye, and injuries caused by these rays to the eye have been studied very thoroughly in certain quarters ever since by eminent experimenters. Briefly stated, all of them have shown that the anterior structures of the eyes are inflamed by ultra-violet rays and that the human lens is injured by them, causing cataract, but that the lens absorbs these rays to a variable extent, thus protecting more or less the posterior structures of the eyes. As might have been expected, it has been shown that the blue and violet spectral light rays cause damage less in degree to the ultra-violet rays. Perhaps the most curious demonstration is that made by Dr. A. Birch-Hirschfeld. Eyes which retain the lens and the retina and are sensitive to ultra-violet rays are also sensitive to infra-red rays, but eyes without the lens are sensitive to ultra-violet rays only.

In 1887 Dr. Van Generen Short, in his experiments upon animals, found that the chemical rays of light which were not absorbed by the lens of the eye produced disassimilation of the retinal pigment. He found that the disassimilation and cell wandering was at a minimum in yellow light, which is, of course, the light which contains the luminous rays in the greatest quantity. Following these experiments, Fieuzel suggested that protective glasses for the eyes should be of a gray yellow color. Snow blindness and injuries from the electric light are both due to the chemical rays of light, including the ultra-violet rays. Snow blindness occurs only in the rarified atmosphere, because, as Tyndall showed long ago, the chemical light and ultra-violet rays are absorbed by the dust of the atmosphere. This gives a yellow tone to the light. Mr. Moore remarked that we do not have such a thing as constant daylight, and he picked out as a standard light, light on a cloudy day. Von Helmholz said that the best standard light was that found just inside a closed window, where the sun did not shine, on a bright day.

Wm. M. Bouchelle.—I ask Mr. Stickney why it is that although he has demonstrated to us that the white light of the electric arc shown in his experiment probably approaches nearer daylight color than any of the other lights, yet Dr. Elliot and Professor Day place the yellow kerosene lamp ahead of the white arc as the light suitable for the eye. I do not quite understand that. We know that both these gentlemen have written recently on the subject and both have placed in the first place the yellow kerosene lamp as a safer light for the eyes.

T. J. Litle, Jr.—In the demonstration made by Mr. Stickney, unfortunately the best mantles were not used, but instead those giving what is known as a greenish-white light. In order for the Welsbach mantle to give a mellower light, the cerium content has been increased. We find that by so doing we increase the number of red rays and neutralize some of the green rays. I performed a very simple experiment in the laboratory recently by placing a bright red cone reflector above one of these green-white mantles, thereby increasing the red rays in the light thrown below the lamp, and differently colored calicos placed below the lamp immediately assumed their true tints, they having been first examined under daylight. The same material was then viewed beneath the light from a standard high grade Welsbach mantle, and the same result obtained as with the red reflector, showing that the green-white mantle could be improved in two ways: first, mechanically by the use of a red reflector, and second, chemically by increasing the cerium content. I believe the time is soon coming when all artificial light will be toned down to a soft color.

E. Y. Porter.—It has been said that the electrical engineer should be one-tenth an electrical engineer and nine-tenths a steam engineer; and I think it might be equally well said that the illuminating engineer should be one-tenth an illuminating engineer and nine-tenths an oculist, because really the effect of illumination upon the eye is the important thing. We illuminate only to be able to see, but if thereby we either injure or deceive the eye we are defeating the end which we are striving for. I believe more important than toning down the color to a neutral color is the matter of toning down the intensity of the light from that which is too strong for the eye to some-

thing which is safe. If the light does not glare, I think the actual injury to the eye will be very slight, within quite a range of colors. As to the question of the white light, I think the matter is again a question of intensity. White light is all right if it is not too brght. I am very strongly of the opinion that we will eventually come to use white light, that is daylight, or its nearest equivalent, for most purposes. We have to go gradually, because people are not accustomed to that color for artificial light. I have noticed that as people get accustomed to a white light they prefer it, provided it is not to intense. We can hardly hope to improve upon Nature's color, and I am sure that is the color for general purposes which we should try to obtain; but unfortunately that means at greater cost. We see that in the flaming arc; we duplicate daylight more closely by the use of certain chemicals, but at a loss of efficiency. The same is true of the Moore tube. In other words, if we have to distribute energy over all the spectrum to get all colors, we must take more energy to get a given effect on the eye than if we concentrate the energy on certain given colors, green and yellow, which affect the eye most strongly.

As illuminating engineers we ought to try to eliminate as many of the variables as possible. We have been talking very glibly about the watts per square foot and the watts per candle power, and the various other factors. At the last meeting I mentioned the illuminating efficiency as being the ratio between the watts per square foot and the average intensity. This is only one step toward arriving at some term which will express the real value of any light, or system of lighting, from the standpoint of efficiency, and it does seem to me that it should be possible to take another step forward by referring the efficiency of all lights to a standard color. I believe it is possible to work out the relation, say, between a yellow light and its equivalent white light and get a definite basis of comparison for different colors, because we will always want certain colors for certain purposes and must be able to reduce these various colors to a common denominator before we can speak of efficiency with any definite meaning.

G. H. Stickney.—From the general trend of the discussion I think perhaps that I have given the impression that I considered the arc lamp sort of a panacea for all lighting ills. I did not mean to do so. There are certain places where the enclosed arc light is unquestionably the most desirable illuminant available. In the lighting of large areas where good general illumination is desired, and especially where color values are important, as in department stores, we have been able to obtain the best results by using the enclosed arc lamp, modifying the light distribution to suit conditions.

There are certain places, such as restaurants, residences, etc., where it does not seem desirable to illuminate with white light, yellow tinted light being preferable. In such cases, and where areas are small and ceilings low, it would be a mistake to install arc lamps.

Meeting of the New England Section, May 14th

Topical Discussion on Photometric Instruments

Professor Geo. C. Shaad.—A couple of years ago I had occasion to make some tests upon the mercury vapor lamp, and in connection with these we attempted to make some measurements of illumination obtained from this lamp. It is well known that the color of light produced by the mercury vapor lamp is distinctly green, and this is one of its main disadvantages; but the fact that the green color of the light does not seriously affect the plain white and black colors, as we call them, led to the suggestion of the use of the mercury vapor lamp for draughting room work, and this was one of its first applications. The draughtsmen soon become used to the effect produced on different colors and do not mind it, but to one who is not used to it the effect is decidedly unpleasant. It was thought that if the green rays of the mercury vapor lamp could be combined with the red rays which are more or less present in the light of the carbon incandescent lamp, the result of the two would bring about effects equivalent to those from a white light source or from daylight.

It was with the idea of investigating the effect of this combination that a draughting room at the University of Wisconsin was fitted up with a combination of these two light sources. The room was one which happened to be most convenient and no particular pains were taken to get the best effect of light, but the regular incandescent sockets were fitted with "Meridian" lamps and mercury vapor lamps were mounted as found most convenient.

Following are some data on the room we illuminated and on the lamps used:

The room was 44 feet long, 25 feet 6 inches wide and 12 feet high, finished in a light yellow tint. One side was badly cut up by windows. The other was irregular in form, due to ventilator flues, but the two ends were fairly smooth. The windows were covered with rather dark shades.

The incandescent lamps were of the "Meridian" type, that is 120 watt lamps, with aluminum reflectors, giving approximately 50 candle power in a downward direction. Thirteen lamps were used, and the total power taken by all the incandescent lamps was 1590 watts. These lamps were mounted six feet above the floor. The mercury vapor lamps used were five in number—one 110 volt 700 candle power unit and four 55 volt 350 candle power units. The power consumed by the mercury vapor lamps alone was 1089 watts, approximately two-thirds of the power supplied to the incandescent lamps. The mercury vapor lamps were mounted about eight feet from the floor, and the various portions of the tube varied from a little less than eight feet to a trifle more than that.

After the room was equipped, the measurements of illumination were taken at what corresponded to the regular positions of the draughting desks and on a plane corresponding to the surface of the drawing boards, about fifteen degrees off the horizontal. The readings were taken at what would correspond to the center of the boards; there were 32 boards in the room. In taking measurements of the illumination the only instrument at hand was a Weber photometer. This gives excellent results with the incandescent lamps and it gave good results with the combination of the two, but when it came to taking readings of the mercury vapor lamp alone, we had the problem of comparing lights differing greatly in color, and we expected to have trouble in getting balances. The idea was more to get comparative rather than extremely accurate results, but we were somewhat surprised to find that two persons, judging the comparative illumination of the screen, would set the photometer quite closely, that is perhaps within five per cent.; and again, the one observer, taking readings at successive periods, was able to determine the balance quite accurately, if that may be judged by the way in which the readings corresponded with one another.

The readings were taken with the incandescent lamps alone, with the mercury vapor lamps alone, and finally with a combination of the two. The illumination calculated from the readings with the combination exceeded, by a considerable amount, the sum of the two illuminations taken with either light source alone. The general result showed that the average illumination obtained (I speak now of the illumination as we measured it, with the Weber photometer), with the carbon incandescent lamps alone, was 1.1 candle-feet, which is a trifle lower than would be considered good illumination for draughting work. The values obtained by the use of the mercury vapor lamps alone, where we had the greatest difficulty in getting balances, was two and one-half candle-feet. With the readings for the illumination from the mercury vapor lamps taken with the instrument in exactly the same position, and by the same observers and on the same evening, the results showed that with about two-thirds as much power for the entire room the illumination with the mercury vapor lamp was about 2.2 times as great as with the "Meridian" units. The sum of the average illumination measured separately amounted to 3.6 candle-feet, but the value shown by the readings of the photometer for the combination lighting was 4.5 candle-feet, forty per cent. greater than that given by adding the two independent readings.

So far only three explanations of this effect have been offered. The first is that there was an error in the calibration of the instrument. This was carefully checked and found to be correct. Then, to be sure of results, the readings in the draughting room were checked and the second readings were within reasonable limits of the first ones. The second explanation is that the discrepancy was due to the use of a photometer of this type for comparing lights of such difference in color. This seems reasonable in a way but does not account in my mind, for so large a discrepancy. The other explanation is that by combining the rays of the different colors, that is,

combining the red rays which are quite prominent in the incandescent lamp with the green rays of the mercury lamp, we get a condition where we really have, measured by the eye, better illumination. I have been unable to carry the investigation far enough to say whether this last is a proper explanation. In fact there is some doubt in my mind as to what method we could use to make such a check.

At one time one of the manufacturing companies was exhibiting a combination lamp made up of mercury vapor lamp or tube surrounded by incandescent lamps and the whole enclosed in a prismatic globe. This was apparently done to add to the green rays of the mercury lamp the red of the incandescent lamp and thus improve the color, but I have never seen this lamp in actual installations.

My own opinion is that the discrepancy found was largely due to the attempt to measure illumination, due to such color sources, with the Weber photometer.

Preston S. Millar.—We have used the Weber photometer in tests of mercury vapor lamps, but of course have not been able to get rid of the color effect. We adopted the expedient of standardizing the instrument by a mercury vapor lamp whose intensity had been measured previously by a number of different photometers. In standardizing the Weber photometer with this lamp at the same intensities found in the installation under test, we made use of the substitution method and considered that we had eliminated all serious errors due to color effects.

I cannot see how any error due to the color of the mercury vapor light alone would occasion the decreased value which has been advanced as a possible explanation of the discrepancy noted by Professor Shaad. It seems to me that working with, perhaps, a low intensity of illumination on the photometer, errors of this kind would occasion a result which would be too high, due to the Purkinje effect.

Dr. Williams.—As I understand it, one of the theories of color perception is that we have in the eye three photo-chemical substances—one responding mostly to red, one to green and one to violet. Now a combination of red and green would cause a sense of yellow. The question which occurs to me is whether by combining red rays and green rays you were not getting a sensation, so to speak, of the yellow shade, which would give a greater luminosity in the way of reflection from the surface of a paper than you would get from either the red or the green alone. Has Professor Shaad considered the question of the yellow effect produced by the combination of green and red lights?

Professor Shaad.—That explanation has been given. That is what I mean by the statement that we really get a greater illumination, as measured by the ordinary sources—that is, the combination of the two gives a color of light by which we could perceive things with greater distinctness, the light appearing to be of greater intensity and enabling us to read finer print than with either color alone.

I meant to add that the result of the two, as far as appearances on the draughting board are concerned, was much the same as you would get by increasing the potential of an incandescent lamp so that it runs at over-potential and produces a whiter light. The bad effect of the combination, of course, was apparent in looking at the light sources themselves, the red rays of the carbon lamp bringing out the green of the mercury lamp and the green bringing out the red of the incandescent, so that the effect was disagreeable.

Dr. Louis Bell.—In matters of photometry, in measuring one light source in the ordinary sense against another, there is, in a general way, considerable concurrence in the instruments used. A wide range of instruments is employed, all of them depending substantially on the matching of two contiguous light effects. In the Bunsen screen the light effects are those on the two sides of the screen as disclosed by the oblique mirrors. In other photometers, which came out later, we have still the same general device, the bringing of the two illuminations, the intensity of which is to be judged, into sharp contiguity with a clear line between them. In the flicker photometer, another criterion is used—the sensitiveness of the eye to a flicker; but in some of the forms even of that instrument the observation practically depends upon the matching of two contiguous effects. When it comes, however, to measuring illumination, that is, the light received from a given source on a surface, difficulties multiply. Any photometer of course can be used to take a given section of illuminated surface and to measure its intensity as a secondary source, but that process is sometimes very inconvenient. Most photometers, having a bar two meters in length, are not altogether convenient things to carry about; and up to the present the only

form of photometer that has come into standard use for that purpose is the Weber, which after all is merely a Lummer-Brodhun screen with appropriate attachments which render it more or less portable—rather less than more, I may say. There have been, however, a good many attempts to get a luminometer which shall measure illumination directly, not by the process of balancing one illuminated surface, or one flicker against another, but by the process of observing something, the disappearance of which indicates a more or less definite point in relation to the illumination. Most of the luminometers with which I am acquainted depend practically on visual acuity, the fact that you cannot make out fine detail as well in poor light as in good light. In certain of the forms another phenomenon comes in—that of shade perception, which amounts to this, that the eye cannot in a dim light detect small differences in shade or luminosity of a surface as well as it can in fairly brilliant light. Most of them, however, depend on acuity, either on reading type at a distance from the lamp, or reading type which is screened more or less by the interposition of translucent substances. Whether one depends on acuity alone or on the shade perception, would perhaps make comparatively little difference. In either case there is this difficulty, that both shade perception and acuity rise rather quickly as the illumination increases, and both reach a fairly normal value somewhere around one or two foot-candles. Consequently all the extinction instruments have to work below that intensity, measured as reaching the eye. Otherwise you might make great change in illumination without any perceptible change in the acuity. In the ordinary luminometers, type or characters of some kind are read in a gradually reduced illumination until one fails to perceive them or just perceives them, according as the point at which the reading shall be taken may be chosen. I learned from an English friend the other day that they have abroad a peculiarly British method of determining illumination, to wit, the proper street illumination is that by which one can read the *Times*, which quantity is about one-twentieth of a foot-candle. One-twentieth of a foot-candle is really a perceptible amount of light. The light of one acuity photometer is shaved down to one six-thousandth of a candle, which is too little for any useful effect. Perhaps the simplest of the illumination instruments with which I am acquainted is that devised by Dr. C. H. Williams. That instrument is remarkably compact and simple, but needs to be modified somewhat for the use of the practical measurement of illumination such as we find it. It is merely a photographic wedge—in other words, a plate, developed to a fixed gradation so that at each particular point of the slider in the instrument a definite amount of light will be cut off. The photographic wedge has been of great assistance in stellar photometry, and can be made with a very high degree of accuracy. The degree of precision in making the instrument is vastly greater than we can hope to get from any measuring of the illumination in the ordinary way, on account of the limitations of the eye. The photometer as now made is graduated in stellar magnitudes—that is to say, the amount of light cut off varies along the slider, not in linear proportion, but in the same proportions as stellar magnitudes which are connected by a ratio of which the logarithm is 0.4: that is, a difference of one magnitude corresponds to a multiplier of two and one-half. The instrument as developed here was used largely for the purpose of getting a line on the relative intensity of distant light sources. For operations in measuring intensity the instrument can be easily used as an extinction instrument on a definite kind of type. To use this simple form of photometer for measuring illumination, it is necessary to calibrate the particular wedge which one has, by tests in reading type, getting the point of the slider at which the type becomes legible in a known illumination. On the particular wedge which I have, there are eighteen magnitudes included. Beside that, the eye is unable to recognize the point of extinction uniformly at all times. In other words, the state of adaptation of the eye in all instruments of this type makes it difficult to recognize the point where extinction comes. However, we must take that as it comes, as we cannot improve the eye. In order to interpret card readings the simplest possible way is to draw a logarithm-scale on co-ordinate paper, depending on the cut-off determined with known light. That is perhaps the most simple and direct form of the acuity type of luminometer. For such purposes as measuring illumination, it would be much better to use a wedge made specially, with a very much less difference in density between the two ends. One can thus make the reading easier, because one never has, under any circumstances, to count on an illumination

which he can read at the very dense edge of this particular wedge. In precision, I should imagine that the instrument was practically within ten per cent. or something of that sort. This is about as well as one can do with an acuity instrument. A ten per cent. performance is not striking as regards scientific precision, but is a great deal better than any kind of visual estimate; and with a wedge made with much less density and intended for this particular kind of work, I feel sure that a much better result could be obtained.

The second form of instrument to which I am going to call your attention is a photometer which is for a slightly different purpose. It is got up primarily for the purpose of comparing the luminosity of two different surfaces, and for that purpose a box is provided. It is simply an embodiment of the general idea of bringing two contiguous surfaces into such relative position that the luminosities can be easily judged. A septum divides the box in which there are two translucent screens which let the light through. The light falls through the screens upon two samples which are to be compared, which lie side by side in the screen clips, and are viewed by mirrors, so that what is really seen in the field are two surfaces illuminated by the same amount of light coming through the two translucent windows respectively, and these surfaces are observed by means of the two mirrors. Now there must be means of varying the light on one of these surfaces so that the luminosities may be compared. In the "Simplex" photometer the means taken is a photographic wedge. In the Munsell photometer the means is an extremely precise quadrilateral square opening which, by moving its two parts, can be contracted, still maintaining its shape, into a minute opening and even entirely closed—a device known as a cat's eye. It cuts down the amount of light which passes through the illuminating window in a perfectly definite way. It is as precise as can be in regard to illumination. Here again the instrumental precision is far and away above that realizable in practice, because the eye, in measuring colored light, fails long before the possibilities of the instrument are exhausted. Shutting up the cat's eye until the approximate luminosity is obtained, it would appear that the pink paper is about 74 per cent. of the luminosity of the white paper. Obviously, by letting one of these windows be lighted from a standard light at a known distance and calibrating the instrument accordingly, one could obtain a good measurement of daylight or artificial illumination of any kind, but there is no special provision for using such standard light; and I may say, that in any attempt to reduce any such photometer to portable terms, the question of a standard light is the one crux of the problem. The best means is probably an incandescent lamp and battery, holding the current in the lamp constant. The Munsell photometer, therefore, although in a sense a luminometer, is especially adapted to comparing the luminosity of two surfaces, for which it is very convenient, but is open to a difficulty which we always meet in the question of color comparisons. The exact point at which the luminosity of a pink and of a white paper are the same is something which puzzles the eye, even under the most favorable circumstances. I imagine the amount of precision attainable is about the same as in the Weber, or the Bunsen photometer, or any other form in general use. The color difficulty is always with us, and until we settle upon some conventional means of comparing colored lights, difficulties of this class will always confront us; and unfortunately the apparent magnitude of these color differences, as judged by the consistency of the readings obtained, is no exact measure of the real relations, because it has been found that observers fall into habits in that way, and two observers may fall into the same habits, while both of them are rather far from the facts in the case as found by applying other means of measurement.

Professor Shaad.—Dr. Bell has outlined the general principle of the regular type of photometer used for measuring the intensity of light sources, and the Weber photometer may be used for the same purpose, but to use it as an illuminometer some sort of screen is utilized, to be illuminated by the light sources and to be placed at the point and in the plane in which we wish to measure the illumination. The screen to be illumined can be readily changed to any angle with the horizontal, and the photometer can be easily changed itself so as to be accommodated to the observer. For instance, the observing tube is arranged so that it can be turned to any angle in a vertical plane. The horizontal tube, on which readings are taken, is arranged so that it can be readily changed in a horizontal plane, and the screen for illumination can be placed in any position: so long as it does not make too great an

angle with the observing tube, and so long as it is not at a distance from the opening of this tube which allows the edges of the screen to come within the cone of light from the Lummer-Brodhun prism. If we wish to measure the illumination at some point and at some angle to the horizontal, the opening of the observing tube is placed as close to the screen as is convenient, so that it comes within the cone of light from the prism. The light then reaches the prism as reflected light from the surface of the screen and is balanced against the standard light. The standard lamp, which is mounted at the end of the horizontal tube, throws its light against a diffusing plate located in this tube. A rack and pinion moves the diffusing plate backward and forward inside the tube, and its position is read by means of the pointer moving along a scale on the side of the instrument. The standard lamp, for convenience, is made a small incandescent lamp which is operated by a storage cell. In some of the first types of photometer a benzine lamp was used as the standard, and it serves very well as a standard of light so long as the same quality of benzine is obtained and so long as the flame height is kept within very close limits. The diffusion screen is moved backward and forward until the illumination on the photometer screen from the diffused light from the standard is just equal to the illumination from the card where it is desired to measure the intensity of the illumination.

In order to determine the candle-feet of the illumination then, the instrument must be calibrated. It is not a direct reading instrument in the sense that some instruments are direct reading, but a calibration curve must be made up against a standard illumination, as with the other types which have been described. This calibration is a comparatively simple matter. A light of known candle power is placed at a fixed distance from the screen so that the rays of light fall perpendicularly to the screen. The instrument is then read with this illumination, and by taking a series of readings, varying the intensity of the illumination, by moving the light back and forth, and the instrument is calibrated, and a curve obtained so that by taking readings of the diffusing screen which causes a balance on the photometer prism the illumination may be read from this curve directly in candle-feet. For bright illuminations, a series of translucent screens is furnished with the instrument which may be placed so as to absorb a portion of the light falling upon the prism from the illuminated screen. These plates in turn must be calibrated, as each one has a distinct constant which must be known. If it is desired to use the instrument over a considerable range, the best way is to take it to where the readings are to be obtained, then return to the laboratory and calibate it over this particular range with the plates which were used. The instrument alone, without the laboratory back of it, is not very flexible.

R. B. Hussey.—An instrument, designed by W. D'A. Ryan of the General Electric Co., about six years ago, has been used practically for measuring exterior illumination, that is, measuring the intensity of light obtained from street lamps in their positions in ordinary commercial service. This instrument is a type reading instrument, and consists of a simple box with eye piece and light shaft. A card printed with plain type of some particular size, or of different sizes, is placed in the box directly opposite the eye piece. The light from the lamp to be tested shines in through this light shaft directly upon the card. This instrument may be used at different intensities, according to the size of type used and the calibration. We have used it a great deal, with very low intensities of illumination, somewhere from 6/1000 to 1/100 of a foot-candle, that is, at a distance of from two to three hundred feet from ordinary street lamps. The instrument may be calibrated by use with some lamp of known intensity. We have standardized it with a sixteen candle power or other standardized incandescent lamp. The process simply consists in calibrating, as it were, one's eyes to a given distinctness or to nearly extinction of the type used under the standard lamp, and then obtaining the same degree of extinction under the lamp to be tested. This method is capable of close readings with a little practice, but one must train himself or his eyes so that the type can just barely be read. We have found the most sensitive point to be that at which the letters can be barely made out. If one tries to read too distinctly, the sensitiveness of the instrument is somewhat impaired. With practice we have been able to obtain very close results, and by calibration these can be reduced in terms of foot-candles or any other unit that is desired.

Another instrument, dependent on an entirely different principle, is used for either interior or outdoor use. This is a simple

photometer for carrying a small lamp for a standard, which may be an ordinary carbon, a tungsten or any other kind of incandescent lamp. The lamp is mounted on the end of a shaft which is connected by means of a socket and cord to any source of supply, and the variation is obtained by sliding this lamp in the box. The essential feature of the instrument is the screen. This is composed of a special white opal glass without any considerable amount of selective color absorption, so that it introduces practically no color difficulties other than those met in the ordinary comparisons of color. This screen is in the form of a cube cut diagonally. The surface on which the light shines is ground, so that a non-reflecting diffusing surface is obtained, while the adjacent surface is lighted by means of the standard lamp in the box. The two halves of this cube are separated by means of a thin opaque medium so that no light can pass from one half into the other. The illumination from the lamp or combination of lamps to be tested is received on the top surface and lights one-half of the cube. The illumination from the standard lamp lights the other half, and the junction between the two halves is viewed through a small eye piece of the cube. By changing the distance of the standard lamp from the screen a balance is obtained which can be judged very closely. A diaphragm may be used between the standard and the screen in order to give a greater range to the instrument. This instrument can be worked through a large range of intensity. We have used it from as low as about one-tenth of a foot-candle up to over 50 foot-candles, by the use of different lamps, but using the same screen, and this has the further advantage over many instruments that it can be used at any angle. We have used it on horizontal measurements and on the measurement of the illumination on walls. The instrument has been found to be as exact as other instruments used for the same purpose. Of course the same color differences and difficulties are brought in that are met in any of the photometers already described. If we are obtaining a balance between an arc lamp, for instance, and the standard incandescent, there is bound to be a considerable difference in color between the two halves of the observing cube. This can be partly overcome and is in practice, by using a standard lamp which is somewhat colored. I have used one which has been given a slight bluish color, which enables the balance to be obtained more easily and quickly.

John Campbell.—In the luminometer as produced by the General Electric Company, a certain set of type is arbitrarily adopted, and there are various cards and various sized types, and on the same work a different set of men may take different sets of type and get comparatively different results, when actually they would have been the same if the same standards had been used. Oculists have adopted a certain standard type for their purposes, and it seems to me that wherever type is used in measurements some certain fixed form or standard of type should be adopted.

Dr. Bell.—The real difficulty there is calibrating and maintaining the standard lamp, practically as great as it would be in the Weber photometer. Is a voltmeter employed on the lamp in the instrument described by Mr. Hussey?

Mr. Hussey.—An ammeter is usually preferable, because it is apt to be more accurate in that it eliminates errors due to poor contacts.

Dr. Kennelly.—How do the observations with the two instruments compare?

Mr. Hussey.—The first one is used for a much lower intensity and the readings with the luminometer are usually put down as a reading distance of so many feet, which, if the observer calibrates his eyes, can be reduced to candle power in that direction. The second one measures directly in foot-candles and is not dependent on the direction or distance of the light source. The rod has simply an arbitrary scale.

Dr. Kennelly.—With which would you rather test an arc lamp?

Mr. Hussey.—We have used the first one more for arc lamps, though a modification of the second one is now being made for this purpose. We also have been making the screen of different shapes for other work. The illuminometer lamp can be run by a storage battery or by connecting to any ordinary lighting circuit, with an ammeter or voltmeter to give control of the standard.

Dr. A. E. Kennelly.—A little instrument, of the pocket variety, consists of a rectangular wooden box, blackened internally, with a test object at one end on a wooden wedge, and an eye piece at the other. Type may be employed. The card is exposed underneath a window of opal glass. The thickness and translucency of the glass are such that a bright object cannot be seen through it directly. The light is almost entirely diffused. A draw tube is employed with a lens in such a manner that the ob-

server can focus his eye or obtain a sharp image so as to obviate any difficulty with visual accommodation, and a metallic shutter is moved by a screw so as to occlude a greater or less amount of the opalescent window. Consequently, by setting this instrument on a table or any other place where the illumination is to be measured, the observer, with a black camera cloth over his head to protect his eyes from extraneous light, looks in and turns the screw until he can just see or fail to see the test object, and at that point the relative position of the shutter, and therefore the secondary illumination on the test object, is made evident on the scale. The only difference in principle between the luminometer and this instrument is that the luminometer is intended to operate by direct illumination from a single source, whereas this instrument is designed to operate by reflected light as well as by direct illumination. That is to say, the luminescence of the opal glass is only partly due to the direct illumination. It is also due in part to reflected light from the walls and ceiling. The probable error of a single setting of this instrument is, for an untrained observer, one who is accustomed to make photometer observations but not with this particular instrument, approximately ten per cent., and that of course is not a high degree of accuracy; but, as Dr. Bell says, it is much better than nothing, and without any instrument the estimations we are likely to make of illumination upon a given surface are only very rough. This is a rough instrument, but at the same time it is portable and can be easily carried in the pocket.

Mr. Campbell.—Perhaps some of us fail to realize how much work there is in the laboratory testing of arc lamps, and I would like to ask Mr. Millar to tell us something about this.

Mr. Millar.—As a matter of fact my work with arc lamps has been rather limited. However, one of the great and fundamental difficulties in arc lamp photometry lies in the marked changes in intensity inherent to the operation of the arc lamp. In any photometric work, such as the measurement of arc lamps in the street or in the laboratory, this difficulty becomes very apparent. At one moment the observer may be working in a bright beam of light, and in the next moment in a shadow. In laboratory work this effect has been minimized in an instrument designed by Professor C. P. Mathews, of Purdue University, who has constructed a ring of mirrors in the center of which the arc lamp is hung. By opening mirrors located at suitable angles on apposite sides of the lamp, he measures the sum of the intensities on opposite sides of the lamp simultaneously, and thereby averages the higher and lower intensities and obtains in much shorter time and with much greater accuracy what may be considered a fair photometric value for the lamp.

The Weber photometer has been used somewhat in arc lamp photometry, but when it comes to practical work this is a good instrument to avoid. Optically it is an excellent photometer, but at least in the model with which I am familiar large errors are present. In measuring illumination under certain conditions, we found originally errors as great as 30 per cent. In the correction of these we spent perhaps three months and finally succeeded in obtaining an instrument capable of considerable precision, as this word is applied to photometry.

I have been working some upon a visual acuity instrument somewhat similar to that shown to-night by Dr. Kennelly. My instrument, however, has been made larger, since I consider it better to have an instrument somewhat less portable but without the error found in this small instrument, due to the fact that the head of the observer must cut off a great deal of light from the test plane. However, I was unable to obtain an accuracy of ten per cent. In a photometer room, working under the best conditions, with an instrument of this character, I could approach an accuracy of ten per cent. In a lighting installation where the conditions were less favorable, I could not even approach it. The results were particularly bad unless the eye could be blinded for perhaps five or ten minutes before making an observation, and could during the observation be well shielded from all view of surrounding objects.

At Harrison, N. J., J. T. Marshall is developing an instrument. He uses a miniature lamp at the base of a vertical cylinder. On the top of the cylinder he places a disc very similar to a Bunsen disc. By means of a gauge this disc is always observed at the same angle. The photometric setting is made by noting the point of disappearance of the more translucent part of the disc, and by varying the intensity of the miniature lamp until such disappearance is obtained. As I understand the arrangement, he then measures the resistance of the miniature lamp with a simple Wheat-

stone bridge, having a slide wire in one arm. This slide wire is calibrated in some unit which may be interpreted into foot-candles by means of a curve. His is the most portable instrument which I have seen for measuring illumination under certain conditions. I am not in a position to make any statement regarding its accuracy. However, at the last meeting of the American Institute of Electrical Engineers, this instrument was used in measuring the horizontal illumination produced by the Moore tube and two incandescent lamp installations and statements regarding the relative efficiency of the illuminants have been based on the results. Such procedure is obviously absurd, however accurate the instruments used.

D. C. H. Williams.—Some years ago Professor Snellen, of Holland, made a number of experiments and tests to find out what was the smallest visual angle in which objects such as letters could be read by the average normal eye in order thus to get a standard for testing the acuteness of vision. The standard which he adopted, and which has been adopted by oculists all over the world, is a visual angle of five minutes—that is, the letter looked at must subtend a visual angle of five minutes, and the different parts of the letter a visual angle of one minute. This has been found to give in practice the most satisfactory results. If you test young men of student age you will find their visual acuity is often more than that. During middle age it comes down to about that point, and as a person gets older the acuity falls off. We may consider a visual angle of five minutes to represent the normal average acuity in the average healthy eye. With the reading test types of the American Ophthalmological Society, which were worked over for about a year in order to perfect them, the figures between each paragraph indicate the distance in decimeters at which the short lower case letters subtend a visual angle of five minutes. The Snellen five-minute visual angle was taken as the standard in all these various sizes of reading types. Thus you have a definite standard to go by which has been adopted for visual tests, and it seems to me that it would be desirable in the different forms of photometer, depending on the reading of letters or characters, to have a standard size for such letters which would correspond to the standard visual angle of five minutes.

There were two points that Dr. Bell, in speaking of my simplex photometer, did not mention. One was that any photometer which depends on the cutting off of light by a photographic film has less difficulty with differences in color than a photometer for instance, like that of the General Electric Company with white glass, for the photographic film is entirely neutral, it has no special selective absorption, so that one measures through it the comparative intensity of red, or of green, or white light, with much less difficulty than with some other forms of photometer where the color would come in as a more disturbing factor. These films of course can be made in various ways. My brother, who has done a great deal of work with X-rays, asked me to get up one the other day, in which the density of the film should increase less rapidly from one end to the other than in the present form, so I made one for him in which the whole length of the film increased only seven stellar magnitudes instead of eighteen. One can arrange those films in any way he likes, and with the lighter films, arranged for use with weaker lights, the error of setting is less because there is so much more motion in setting the photometer for a given difference in intensity. I hope to have these films also made to read in foot-candles. The films are made in a very simple way. At one end of a box about three feet long there is a slit, and for these particular films that slit follows a logarithmic curve so as to get an increase in geometrical ratio. The slit is covered with a piece of opal glass. Half way down the box there is a partition that comes half way up. In the other end of the box the sensitive plate is exposed. The outside of the slit is lighted by a Welsbach light. The sensitive plate receives a varying amount of light from one end to the other, and on being developed gives a film which increases in density in geometrical ratio. Each film is calibrated by a comparison photometer by reference to a standard set of shade glasses made at the Harvard observatory. In this way the density of the films at any point, say No. 5, is the same in every instrument, and this means that at No. 5 the film cuts off an amount of light equal to five stellar magnitudes.

PROCEEDINGS

Papers Read Before Technical Societies

DISCUSSION

Incandescent Gas Lighting, with Special Reference to Inverted Burners

By Harold E. Copp.

Read at the annual meeting of the Institution of Gas Engineers, Dublin.

Though little more than twenty years have elapsed since Welsbach's great invention began to be practically applied, incandescent lighting has developed with such rapidity, and has attained such a remarkable degree of popularity, that the subject must now be regarded as one of the most important connected with the gas industry. It is therefore with no small amount of diffidence that the author ventures to approach such a subject—realizing, as he does, the impossibility of dealing completely with its many phases within the limits of an ordinary paper. There are, however, certain features which, perhaps, appeal more especially to the gas engineer; and though upon many of them there will doubtless be great variation of opinion, the author would, at the outset, ask the members to accept his assurance that in the collection of information, and in the conducting of tests and experiments for the purposes of this paper, he has observed the strictest impartiality.

On looking through the extracts from patent specifications, published from time to time by the technical journals, it will be observed that gas engineers have contributed their full share of inventions relating to the manufacture and distribution; and as the result of much ingenuity and most careful investigation, a standard burner has been produced for the testing of all grades of gas. Yet it is singular that comparatively few specifications relating to the practical use of gas for lighting purposes bear the names of members of this profession. The subject, however, judging from the extraordinary number of inventions relating to it, seems to exercise a great fascination for some people. Unfortunately, a large proportion of the inventions appear to be superfluous; and the process of attempting to discriminate between those which are likely to be useful and those which are not, is necessarily a long and tedious one. It will not be denied that numbers of incandescent burners have been placed on the market which must have had an injurious effect upon the industry; nevertheless, the attention which is being given to the matter by writers and inventors is an extremely hopeful sign, and will doubtless be productive of beneficial results.

The charts showing curves of the efficiency of a few of the burners most popular in the United Kingdom indicate great variations, and prove how necessary it is that those who are responsible for the welfare of the industry should be in a position to recommend to consumers the best burners and mantles for the particular purpose for which they are required. There are four ways by which still further progress may be made: Firstly, by attention to the conditions of supply; secondly, by improvements in burners; thirdly, by the selection of the most suitable mantles; fourthly, by having a perfectly organized and efficient system of maintenance. The great bulk of the gas manufactured is still used for lighting—most of that lighting being obtained by means of the incandescent mantle; and it is only by continued efforts that a time will come when illuminating tests will be abolished, and other tests substituted, relating to the heat-carrying capacity of the gas and its illuminating value when used with an incandescent mantle.

It is doubtless due more to the introduction of improvements in incandescent lighting in general, and that of the inverted burner in particular, than to the competi-

tion of electricity, that the quantity of gas manufactured in the United Kingdom has not increased during the past few years in quite the same ratio as in former years, and that in many towns the output has been seriously decreased. If, however, this can be attributed to such improvements in the uses of gas, the effect can only be temporary, and must, in the long run, prove beneficial. In West Bromwich, the substitution of incandescent lighting by inverted burners for flat-flame burners in churches, public buildings, and factories has in many cases effected a reduction in the consumption of gas varying from 50 to 75 per cent.

Somewhat similar conditions will, in all probability, be observable in the electrical industry, consequent upon the introduction of metallic filament lamps, which can now be obtained at very low prices, and which develop more than double the amount of light from a given quantity of electricity that can be obtained from a carbon filament lamp. But little reassurance will be found in the reflection that present-day voltages are unsuitable for these lamps, or that the supply of metals—such as tantalum, tungsten, and osmium—is too limited to have any far-reaching effect; for doubtless these also are only temporary difficulties. The fact, which the author has proved by experiment, that the tantalum lamp will work for a reasonable length of time with an average expenditure of current not exceeding 1.8 watts per candle-power, should be sufficient to stimulate the efforts of those whose opportunities are the greatest for the improvement of gas lighting.

Recent developments in incandescent lighting demand continual attention to the conditions of supply. Few inverted gas-burners will work satisfactorily with less than 15-10ths pressure. Moreover, it is necessary that the pressures in the district should be more constantly maintained than formerly; and in towns where the mains are overworked, much benefit will be derived by taking charts of the pressures in various portions of the district (say) once a fortnight, and adjusting the works pressure with the object of reducing variation to a minimum.

Mr. Victor A. Rettich, in his paper before the Illuminating Engineering Society in New York, in March, 1906, asserted that inverted burners were unsuccessful in that city, and that fire insurance companies demanded higher premiums for buildings in which they were used, on account of the dropping of particles of incandescent carbon. This state of affairs is probably accounted for by the fact that the gas supplied in New York is credited with an illuminating power of 23 candles, and is distributed at a pressure of from 10-10ths to 15-10ths—conditions which preclude the use of nearly all the low-pressure incandescent burners at present obtainable. The use of water gas also has an important bearing upon the subject; and as this gas requires less air for its combustion than ordinary coal gas, it will be a growing necessity that fairly constant proportions be maintained—inverted burners being particularly susceptible to every variation in the composition of the gas.

Passing on to the consideration of low-pressure burners, the ideal burner is one in which sufficient air is injected and mixed with the gas for its complete combustion, as from this flame the maximum temperature would be developed. But, in practice, at any rate with vertical burners, it is only by forcing the mixture through a small orifice at a high velocity, that these conditions can be approached.

M. Clamond invented an inverted burner in 1905, in which, after it has become thoroughly hot, and has attained its normal condition of working, he claims to inject practically the whole of the air necessary for the combustion of the gas before its ignition. Three-and-a-half parts of cold air are injected and mixed with the gas; and, at the point of ignition, three more parts of heated air are projected into the mantle with the flame. M. Lecomte obtained more than 40 candle-power per cubic foot from this burner.

Of vertical burners, the Kern burner, Figs. 14 and 15, still maintains its supremacy, and is probably as nearly perfect as a low-pressure burner can be made. The Bandsept burner (Fig. 13), which is now used extensively in Paris for street lighting, also gives an excellent result. The mantles with which the tests recorded in Fig. 18 were made were not suitable for the burner, which is of different dimensions to those commonly used in this country, or the results would have been higher. The peculiar feature of the burner is that it has two superimposed injectors, which produce a good mixture, and the flame is highly aerated, even with pressures as low as 6-10ths.

The form of injector used in a burner bears a very direct relationship to its efficiency. It is well known that a certain quantity of gas issuing at a certain pres-

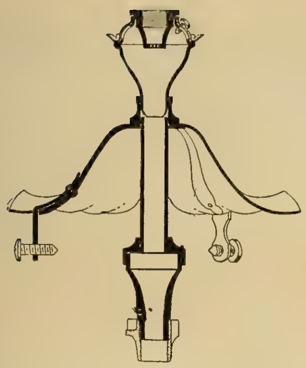


FIG. 1.

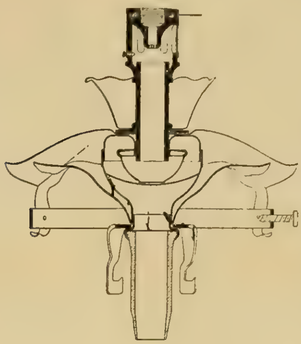


FIG. 4.

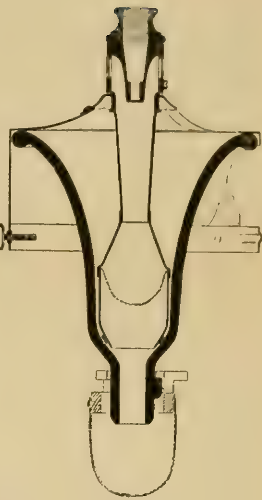


FIG. 7.

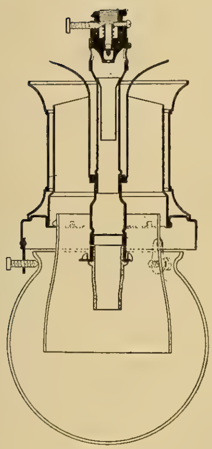


FIG. 2.

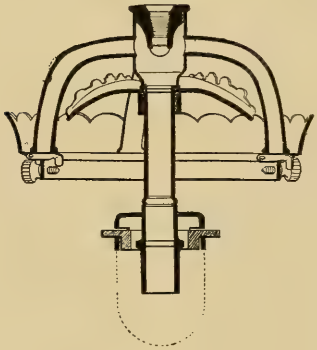


FIG. 5.

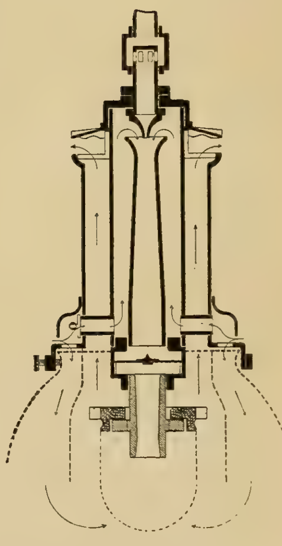


FIG. 8.

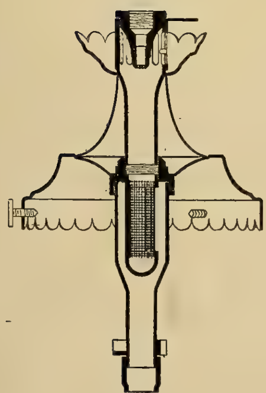


FIG. 3.

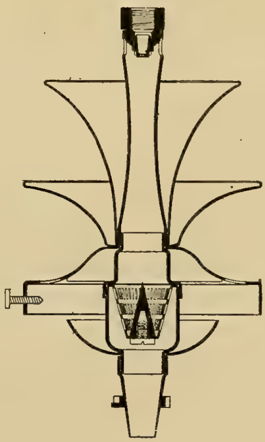


FIG. 6.

TYPICAL INVERTED BURNERS.

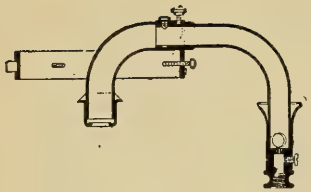


FIG. 9.

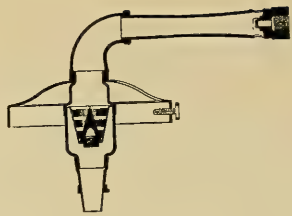


FIG. 12.

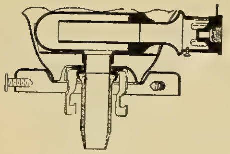


FIG. 10.

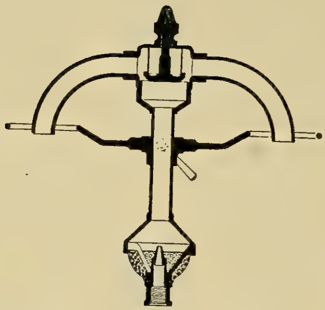


FIG. 13.

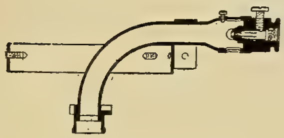
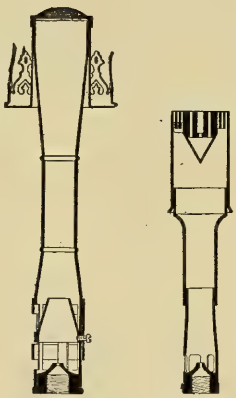


FIG. 11.



FIGS. 14 AND 15.

FIGS. 9-13.—TYPICAL ANGLE BURNERS. FIGS. 14 AND 15.—TYPICAL VERTICAL BURNERS.

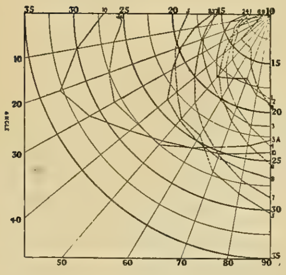


FIG. 16.

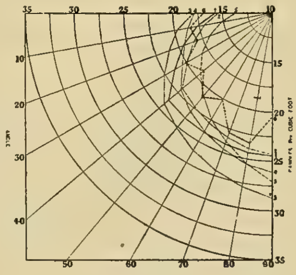


FIG. 17.

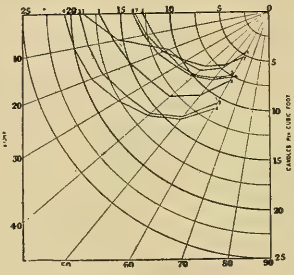


FIG. 18.

FIGS. 16-18.—CURVES OF ILLUMINATION.

sure from one round hole has a greater kinetic energy than has the same quantity of gas issuing from a hole of some different shape, or from a number of smaller holes. The single hole, however, is often objected to on account of the noise it produces. It was stated by Herr H. Süssman before the German Association of Gas and Water Engineers, in November last, that the force available for the injection of air varies directly with the square of the velocity of the issuing gas.

On experimenting with burners fitted with various forms of adjusters, it will be found that the highest efficiency is given by an adjuster in which the hole is maintained fairly circular in form, or in which, if there are more than three holes, the adjustment is made by closing them successively. A needle-valve, in which the gas issues from an annular space, gives a lower efficiency. The author prefers, however, to dispense as far as possible with the use of mechanical adjusters, and finds it generally more satisfactory, when fitting up installations of incandescent burners—especially of the inverted type—to take a record of the pressure at the point where the burners will be fixed, and to adjust them to those exact conditions in the test-room before they are sent out. If this is done, very few complaints will be received, and the use of governors, which means the lessening of the available injecting power of the gas, will be unnecessary. The same course is followed in street lighting, with great advantage.

No less important than the form of the injector is the design and shape of the mixing tube, the correct form of which is well known, but is seldom applied by inventors of burners. After having found an injector which will utilize the maximum energy of the gas, some of this energy can be expended in effecting the thorough mixture of the gas and air in the burner-tube. The shape of the tube, besides its effect on the mixing, ought also to some extent to serve for the prevention of striking-back; and this can be done by constricting the tube at a certain point, and thereby increasing the velocity of the mixture sufficiently to prevent an explosion being propagated back to the injector.

Professor Smithells, in his lecture before the Institution in 1905, stated that the theory of mantle luminosity was a difficult subject. It is certainly one which must be dealt with by the physicist rather than by the gas engineer; but as far as the latter is concerned, whether the illuminating power given by the mantle is due to catalytic action or to what is now known as the theory of selective radiation, the object is to get a flame as hot as possible by effective injection and perfect mixture, and to shape a mantle of the right texture and composition to that flame—the outer zone, consisting of burning carbonic oxide and hydrogen, being the hottest. Professor Smithells found the temperature of the Bunsen flame to be 1,870° C. when fully aerated, and more than 100° C. less when insufficiently aerated; and it has been recently shown by Dr. Gray that a reduction of a few degrees in the temperature causes a great diminution in the light-giving power of the mantle. Vertical burners having an arrangement for introducing a secondary supply of air under the head, and producing a hollow flame, have been tried. The author has, however, found them to be generally unsatisfactory, as the secondary air is not mixed with the gas, and merely exercises a cooling effect on the flame.

Extraordinary as the progress of incandescent lighting has been, that of the inverted burner, in spite of the prejudice which it encountered at first, has been phenomenal; and little is now heard of what was regarded as the fallacy of attempting to burn gas in a downward direction. Professor H. Drehschmidt, in his paper before the German Association of Gas and Water Engineers, on "Inverted Gas Lighting," gives the results of his very valuable investigations, which clearly show what an important effect the future of this system will have upon the gas industry. It is only just over seven years since the first inverted burner of Messrs. Bernt and Cervenka was placed on the English market. It was formerly thought that the first necessity of an inverted burner was that the tube should be as perfectly insulated as possible, either by the use of some non-conducting material or by a metal sleeve arranged to act as an air-jacket. It has, however, since been amply demonstrated that it is only really necessary to have the tip of a burner constructed of non-conducting material.

Inverted burners may now be divided into two classes; the one having for its object the insulation of the burner-tube, and the other the utilization of the facilities which inverted burners present for the pre-heating of the gas and air. The most notable form of the first class is the latest pattern of Messrs. Bernt and Cervenka's burner (Fig. 7), which, it will be seen, gives a high efficiency. Metal tips are ob-

jectionable, as the heat conducted by them from the burner often causes some of the gas to be partially carbonized before reaching the flame; the result being incomplete combustion, causing the blackening of the top portion of the burner or of the ceiling above it, and, in some cases, an objectionable smell. Burners having this defect can often be made to work well by substituting a nozzle composed of either steatite or clay. The chief drawback with most burners whose tubes are well protected from heat is that the character of the flame differs so much when cold and when hot. If it is to be satisfactory when the burner is hot, the flame is so much over-aerated when lighted that it is liable to strike-back. As the burner gets hot, however, it becomes less atmospheric, owing to the decreased tendency of the heated mixture in the tube to descend. The application of the principle of regeneration is thus limited; and, if accompanied by serious diminution of the aeration of the flame, it is much better dispensed with.

It is an advantage that a burner should attain its normal condition of burning as soon as possible after being lighted; and with this object in view, the author has designed a burner (Fig. 8) in which the tube is enclosed in a chamber through which the primary air reaches the injector; so that, as it becomes hot, the tendency of the mixture to descend is lessened, and that of the primary air is correspondingly increased. In practice, the flame of this burner remains nearly as atmospheric when hot as when first lighted; and the inner cone does not perceptibly lengthen, the heating of the mixture giving it a high efficiency. It will be also noticed that the lower part of the burner-tube is larger in diameter than usual, to allow ample room for the mixture after being expanded by the heat, and that the orifice of the burner is specially designed to impart the desired shape to the flame. Another advantage which it possesses, in common with some others, particularly Fig. 5, is that the primary air cannot be contaminated by the products of combustion. (A curve of the illuminating effect will be seen on Fig. 16.) The author has found it advisable not to fix any inverted burner if, after it has been lighted for (say) a quarter of an hour, the inner cone is more than two-thirds of the total length of the flame. Mr. T. J. Litle, of New York, has designed a burner with a thermostat introduced into the tube for the purpose of automatically regulating the air supply as it becomes heated.

In the working of inverted burners, it will be found that most of the complaints are caused by particles of solid matter from the pipes being carried forward by the gas into the injector. Consequently it is advisable, where possible, to fix a suitable dust-trap, especially if a distance lighter is used. In a new burner invented by Mr. George Helps, of Nuneaton, there is an ingenious device whereby the injector (which has a ground joint) can be easily removed for cleaning purposes. All inverted burners should have a suitable canopy or deflector fixed at the top, preferably as a part of the burner, in order to diffuse the heated products of combustion, and prevent them from impinging directly on the ceiling. Aluminum is the best metal for this, being less liable to discoloration than others commonly employed.

The blackening of ceilings attributed to inverted gas-burners is often due to the use of a bye-pass. All bye-passes, after descending to the point at which the particular burner is found to light best, should be turned up, and fitted with a steatite tip. A large number of inverted burners which were disposed of in West Bromwich shortly after they were introduced some five years ago, were apparently made for gas with lower illuminating power than that supplied, and caused so many complaints of smell, and the blackening of ceilings and fittings, that it was found advisable to exchange, free of cost, the original burners for others of a cheap but fairly efficient form; and this course has been amply justified. In the lighting of churches and public buildings with inverted burners, there is risk of the globes or shades dropping, due perhaps to a small hole in the mantle allowing the flame to play on the glass. Where this danger exists, the author makes a practice of enclosing the globes and shades in a network of fine nickel wire.

With regard to the various methods of intensified lighting, the self-intensifying system does not appear to have made any very marked progress recently, depending, as it does, entirely on the length of chimney for its efficiency. If this is unduly increased, the lamp becomes unsightly; while the chimney gives the flame such a high velocity, and elongates it to such an extent, that if a certain length of chimney is exceeded, the efficiency decreases. The wear and tear on the mantles is also heavy, and double mantles cannot be used with

these lamps, as the interstices do not allow the flame to escape with sufficient rapidity.

The various systems in which the gas or gas and air is compressed may now be divided into two classes—the one working with a pressure of from 8 to 15 inches, the other with a pressure of from 40 to 54 inches. Opinions will differ as to which is the better from all points of view. The author's experience is, however, that the higher pressure gives the more satisfactory result. Another system is one in which the gas is compressed to 4 inches, and is mixed (previous to ignition) with two parts of air, or to 10 inches, and mixed with one part of air.

The primary necessity of compressed gas systems is undoubtedly simplicity. The systems working with pressures up to 15 inches can be operated very conveniently by town water pressure; and, for those using higher pressures, a rotary blower will be generally found simpler and cheaper than a reciprocating pump. Those involving the compression of gas or air, however, will not be generally adopted until the plant is much simplified and cheapened. The author has employed a small rotary blower, working at 2 lbs. per square inch, and driven by means of an electric motor or small gas-engine, and has found this method very cheap and efficient; the only apparatus required being a valve for automatically returning the surplus amount of gas, which also acts as a pressure regulator. Adjustments from 10 to 100 inches can be quickly effected, by means of a thumbscrew on the valve; and the pressure is indicated by a mercury gauge.

Various lamps have been constructed with a thermopile operated by the waste heat, connected to motor in the base of the lamp, for impelling the gas forward to the burner. No lamp, on this principle, however, appears to have yet attained any large degree of popularity.

There is another system, which will probably become more popular in the future —namely, that in which the air is compressed instead of the gas. Mr. Scott-Snell utilized the principle by constructing a lamp, the waste heat of which operates an extremely ingenious automatic pump fixed in the top of the lamp. In another application of the same principle, the air is compressed to 2 lbs. per square inch, and is delivered to the lamps through pipes. The air can be used in a special nipple, arranged to inject an increased volume of air with the gas, which may be at a very low pressure. A portion of one of the main streets in West Bromwich is lighted on this system. A volume of air equal to that of the gas consumed is compressed to 2 lbs. per square inch, and delivered to fourteen lamps through a ¾-inch pipe. The apparatus, consisting of a rotary blower, driven by a small water-motor, is fixed in a chamber beneath the pavement; and the air pressure can be arranged to turn the gas on, so that it is only necessary to start the motor in order to light the lamps. Another application of the principle is that in which all the air necessary for complete combustion is delivered inside the lamp. The air so delivered having been previously filtered, the interior of the lamp remains clean for long periods, and it may be used in very dusty situations. The author has had this system at work in the retort-house at the West Bromwich Gas-Works with highly satisfactory results; and there are also other installations at work in the town.

Various high-pressure systems were tried for the lighting of the tramway routes. It was necessary, however, that, as the lamps were to be attached to the poles, they should be of the "arc" pattern; and it was found impossible to obtain lamps of this type suitable for high-power units, which were perfectly ventilated and storm-proof. The system was abandoned, therefore, and small inverted burner lamps were eventually adopted. With regard to the burners for high-pressure lighting, it will be generally found that the simpler their construction the better will be the results obtained; the only necessity being a large chamber containing gauze for ensuring a proper mixture of the gas and air. Several types of inverted burners can be utilized for high-pressure gas, by fitting them with a smaller injector, and attaching a nozzle to impart the correct shape to the flame.

As a result of practical experience with most of the high-pressure systems, the author is of opinion that, unless they are maintained and supervised by the gas company, they will usually be found unsatisfactory. The tests were made with a photometer bar 15 feet in length and the 10-candle Harcourt pentane standard. Though the illuminating power developed by the compressed mixture of equal parts of gas and air was obviously the highest, it was found impossible to obtain a test, as the high temperature developed melted the top of the burner.

In conducting the laboratory tests of

incandescent burners, many difficulties were encountered. First, it was impossible to get one globe, or one type of globe, to fit all the burners. The burners having the ordinary 3½-inch gallery were all tested with a plain conical globe, the top portion of which was of opaline glass, and set at an angle of 45°. Other burners could only be tested with globes with which they were supplied, so that due consideration must be given to this point when comparing the tests. In cases where the burners were not provided with an adjuster, they were first tried without mantles, and the consumption adjusted. After the mantles were fixed, they were tried at various pressures up to 20-10ths, in order to ascertain at what pressure their efficiency was the highest. Excepting in Nos. 10 and 3A, greater pressures than 20-10ths were not used, as they are seldom available at the consumers' burners, at any rate in provincial towns. The burners were then tested at all angles from the horizontal to the vertical.

The curves clearly show the difference in conditions which is brought about by the use of inverted burners. Whereas lighting from the walls of a room was best with vertical burners, lighting from the ceiling is much more advantageous with inverted burners; and it is this feature which makes the latter admirably adapted for the lighting of factories, where there are large numbers of machines. For domestic use, however, for the sake of appearance, the lighting of the top portion of a room should not be altogether neglected. It will be noticed that the burners in which a central glass ring is used in conjunction with a globe having no opening at the bottom, give a high result; the illumination of the mantle being much more intense, owing to the air being more or less heated before coming into contact with the flame. In conducting the tests, the author has been much struck with the variation in the translucent properties of opaque glass. Globes of this material produce a pleasing effect; and some which absorb no more than 15 per cent. of the light, and through which the outline of the mantle is hardly discernible, can now be obtained. It will be observed that elbow-burners are not generally as efficient as pendant burners.

The whole of the tests, excepting those of the large units, were made on a 60-inch bar, with a 10-candle Harcourt pentane standard, and a Simmance and Abady "Flicker" photometer. The standardization of globes and mantles, and methods of testing, would be extremely desirable; but the author confesses his inability to suggest any means of bringing this about.

Although many minor improvements have been effected in the manufacture of incandescent mantles, and those now obtainable are much more reliable than formerly, there is still great room for improvement. It is satisfactory to learn, however, that a new mantle, which is the result of the researches of Messrs. Plaissetty and Bruno, will shortly be obtainable. The mantle is manufactured under a new process, and is claimed to be more or less plastic, so that the risk of fracture is minimized. The Plaissetty soft mantle has been known for a considerable time in this country, and possesses many advantages. Not the least is that it shapes itself to the flame; and not being burned off and collodionized in the same way as the cotton or ramie mantles before reaching the consumer, there is less liability to damage in transit. The mantle, as at first produced, sometimes shrank excessively on being ignited; but this difficulty has now, to a large extent, been overcome. The author has found it profitable to obtain uncollodionized mantles for maintenance and street-lighting purposes, and to provide a small plant for burning them off. This plant consists of a gas-engine driving a rotary blower, similar to the arrangement used for high-pressure lighting. The gas is used at pressures varying from 2 to 5 lbs. per square inch; and mantles can be burned off to any desired shape to suit different kinds of burners.

In conducting photometrical tests of various mantles, it will be found that the relationship of the mesh of the mantle to the character of the flame, is an important factor. A slow and sluggish flame generally gives the best results with an open-mesh mantle, although one of close mesh very often conveys to the eye the impression of giving more light. There are burners and mantles on the market which make full use of this illusion.

The author's experience is that the maintenance of inverted burners is much less costly than that of vertical burners; and in many places where a large number are in use, they can be profitably maintained at a yearly cost of 1s. per burner. The following table gives the mantles used on the various classes of maintenance in West Bromwich :—

MANTLES USED FOR MAINTENANCE.
From October, 1906, to March, 1907 (inclusive).

Type of Burner.	Situation.	Description of Mantles.	Mantles per Burner.
* "B"	Street Lighting.	Collodionized.	3.10
Inverted (square lanterns)	" "	"	2.80
* Inverted (arc pattern lamps)	" "	"	3.35
* Inverted (3 burners per lamp)	" "	"	5.90
'C'	" "	"	5.77
"C"	" "	Uncollodionized.	4.10
Inverted	Shops and Residences.	Both.	3.25
"C" and Kern	" " "	"	4.40
Inverted	Churches.	Uncollodionized.	1.78
"	Schools.	"	2.20
"	"	Collodionized.	5.20

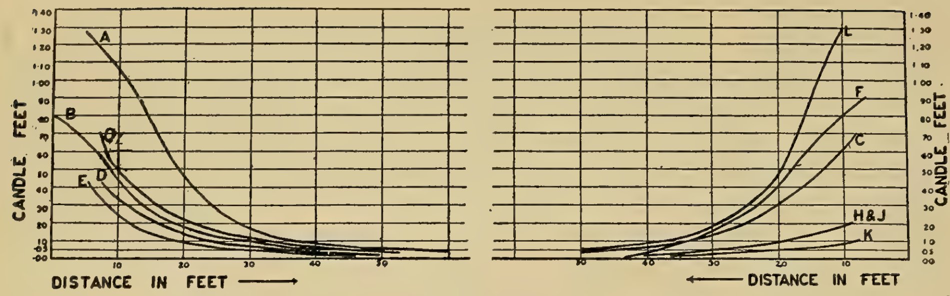
* Lamps fixed on tram poles; mantles consequently subjected to severe vibration.

The difficulties connected with the ignition of burners are, perhaps, more than anything else, retarding the progress of gas lighting at the present time. The pilot-jet, in spite of its many drawbacks, still remains in general use. The greatest difficulty of all mechanical systems is that a perceptible time must elapse after turning on the gas before it can be ignited. There are numerous electrical lighters obtainable; but these are all more or less bulky, and somewhat expensive. Automatic ignition by means of platinum black is not employed to any large extent in this country. There are several small igniters on this principle; but they are slow in action, and often deteriorate rapidly. If, however, they are suspended at the correct point, and the burners are kept clean, so that the flame is thoroughly atmospheric, their life is much prolonged. The author has had several attached to inverted burners, which have been in operation over twelve months. In Germany, self-lighting mantles are employed to some extent—a small pellet of spongy platinum, to which strips of ammonium platinum chloride are attached, being secured to some part of the mantle. But the mantles are somewhat expensive, and are more or less uncertain in action.

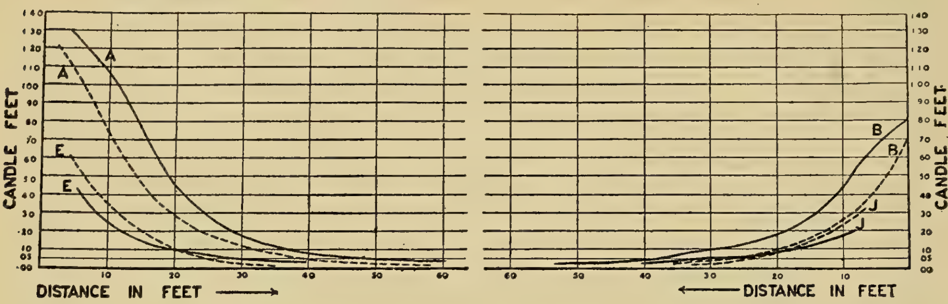
The author has successfully used a coil of fine platinum wire, enclosed in another coil of iron wire for protection from the action of the flame; the current from two dry cells being sufficient to cause almost instantaneous ignition of the gas. The platinum coil lasts for a long time; but not more than three lights can be operated in the same circuit. The gas is turned on by means of a pneumatic switch; and the flow of current is controlled by a bell-push. The pneumatic tube is insulated with cotton, and is used as a conductor of the current; the wire being "earthed" to the gas-pipe for the return. The arrangement in its present form, however, is too expensive to be generally employed.

The well-known device for turning on gas from a distance by pneumatic pressure has been found extremely useful in the lighting of churches, as well as in domestic lighting. In the case of the former, it is often desired to reduce the light during certain portions of the service; and for this purpose the author has successfully employed the pneumatic distance-lighter, in one case by turning out alternate lights, and in others by turning off certain pendants. Bye-passes for these burners will be generally found more reliable than electrical igniters. Though the mixture of gas and air descends from 4 to 8 inches from an inverted burner before it is lighted, ignition can only be effected at a point near to the orifice. Some burners are found to light best with the pilot-jet just below the ring of the mantle, and others with the jet some 2 or 3 inches above the mantle. In church lighting, after the type of burner to be used is decided upon, it is important that this should be determined by experiment; for if a number of burners failed to light during a service, the results might be serious.

There is also another system, invented by Mr. Thomas Glover, of Norwich, and two of his assistants, in which the gas is controlled by means of a tumbler switch, on the principle that when the pressure is reduced by the gas being almost turned off (only sufficient being allowed to pass to keep the bye-pass alight) an automatic valve closes the main supply to the burner. When the switch is moved into the reverse



FIGS. 19 AND 20.—CURVES OF STREET ILLUMINATION.



FIGS. 21 AND 22.—COMPARISON OF METHODS OF TESTING.

position, the full gas supply is again allowed to flow through the pipes; and this raises the valve controlling the main supply to the burner. Water pressure has also been utilized for operating burners from a distance. Baron Auer von Welsbach has succeeded in producing an alloy of cerium and iron which, on being struck lightly, emits a shower of sparks capable of igniting a burner; and it is possible that by this means many of the present difficulties will be overcome.

The curves on Figs. 19 and 20 show the results of tests of various systems of street lighting in use at West Bromwich. It will be observed that, although inverted mantles emit their maximum light in a downward direction, nevertheless, if suitably arranged, they illuminate a road very effectively. Two mantles arranged in a line at right angles to the direction of the road give a much better distribution of light than one. With inverted burners, there is always the risk of a mantle dropping completely off, without previously showing any signs of fracture. When single mantles are used, therefore, it is advisable to enclose them in a fine network of nickel wire, with a clearance of about 1 inch round the mantle. If there are two or more, the appearance is much improved by placing them close enough together to resemble one source of light. The curves are plotted to show the light falling upon the ground surface in candle-feet, as it is only in this way that the degree of patchiness of the lighting by inverted burners can be compared with that of vertical burners.

With a view to projecting some of the downward light from an inverted mantle along the road, a lantern was constructed having a conical reflector at the bottom, as well as at the top; and Curve C shows the improvement due to the use of this arrangement. The lantern from which Curve E was taken is similar to the above, but is only fitted with a flat porcelain reflector above the burner. The curves would, of course, have been much flatter had the light falling upon a vertical plane been plotted instead.

The tests from which Figs. 19 and 20 were prepared were made by means of a Preece-Trotter portable photometer. The tests shown in broken lines in Figs. 21 and 22 were made by means of a street photometer, fitted with a pentane lamp, which was standardized with the flame at different heights on the laboratory photometer with a 10-candle Harcourt pentane lamp—a Simmance and Abady "Flicker" instrument being used in each case.

The Rare Earths and the Incandescent Mantle

By Frederic Bonnet, Jr.

Presented before the Worcester Chemical Club.

Forty years ago scarcely any one thought that the rare earths would ever become technically important. The very fact that the minerals in which they occurred were found in so few localities and in so limited quantities argued that but a few years at best would suffice to consume the entire stock of available raw material. While the absolute quantity in which these earths occur is by no means small, traces having been found in some very common minerals like Apatite, and also in plant ashes and animal secretions, there are only a few minerals which contain them in any considerable quantity. Even in these the earths do not occur singly, but several are invariably associated and substitute one another. Thus cerite, which is essentially cerium silicate, containing from 50 to 70 per cent. cerium oxide, contains also neodymium, praseodymium and lanthamum silicates in greater or less amount depending upon the locality in which it is found.

While an analysis of a mineral containing fifteen or twenty of the ordinary elements might be a tedious process, it would not necessarily be a difficult problem. In the case of the rare earths, however, the complete separation of one earth from the other is beset with great difficulties. This is largely due to the chemical nature of the substances involved. They are so very similar in their chemical behavior that the usual analytical methods fail completely. In the place of qualitative analysis, spectrum analysis is employed, and for quantitative analysis, special methods must be used, which are not only very tedious but may involve considerable loss of material unless each step in the procedure is very carefully manipulated.

The separations are accomplished by "fractionation and recrystallization" methods, which the Curies in Paris made use of in the preparation of radium. These methods were first successfully employed in the early part of the nineteenth century and have made possible the isolation of a number of new elements. The best known of these, which for the present at least may be considered elemental, are cerium, lanthanum, neodymium, praseodymium, terbium, erbium, gadolinium, europium, dysporsium, holmium, thulium, yttrium, ytterbium, zirconium and scandium. Thorium and its radioactive associate, actinium, might be added owing to its occurrence and also to its properties. In giving this list, however, the number of possible, even probable, elements is by no means exhausted, for each year brings new discoveries and the whole group of rare earths doubtless has still many surprises in store for us.

The suggestion to make the rare earths useful for illuminating purposes came from a number of the earlier investigators. Berzelius, the great Swedish chemist; Bunsen, the German, and Delafontaine, the Frenchman, had each described the properties of thorium, cerium and zirconium compounds and each had made especial mention of the intense white light emitted by the oxides of these elements at the temperature of a non-luminous gas flame.

In the early eighties Auer von Welsbach became interested in the chemistry of the rare earths. The incandescence of the oxides particularly fascinated him and filled him with a desire to make them useful. Taking up the matter from a purely scientific interest, he decided that the first requisite was pure material; *i. e.*, pure oxides were necessary. In endeavoring to prepare pure didymium oxide, he tried recrystallizing the double ammonium nitrate, a method suggested by the late Mendeléff. To his surprise he obtained two differently colored salts, one pink, the other a pale green. Didymium was not a true element, therefore, but was made up of two elementary substances which Welsbach called respectively, neo and praseo-dymium. This remarkable discovery led him to investigate the other earths with great zeal, among them thorium oxide, which greatly surpassed all the other oxides in luminescence. In a comparatively short time a serviceable mantle was produced, and a factory for the manufacture of mantles was erected at Atzgersdorf, near Vienna.

Unfortunately Welsbach was called away from his investigations just at the time when a company was formed to finance the undertaking. The services of Dr. Ludwig Haitinger, as head chemist, were secured. Although the chemistry of the rare earths was entirely new to him, he very soon familiarized himself with every phase of the subject. He designed and equipped the laboratory at Atzgersdorf for the production of mantles, and incidentally developed a regular business for the prepara-

tion of rare earth compounds. Not only is great credit due him for calling into existence an entirely new industry, but also for his many scientific investigations in this difficult field. It may be mentioned in passing that he is still a director in the original Welsbach company. Later on Welsbach returned to his old work and he forthwith set about to improve the illuminating power of the mantles, which was not entirely satisfactory, but with little success. The industry of such great promise began to dwindle, and gradually a sort of stagnation set in. For Welsbach this was a trying time. The capitalists, whose expectations had not been fully realized, began to complain or at any rate demurred at further investment. Instead of giving Welsbach time and opportunity for further investigations, they threatened him with legal proceedings. The chemical works at Atzgersdorf were closed and the large number of chemists employed were discharged. With faith in his own work, Welsbach bought the factory and was for some time its only chemist. Something had to be done to save the situation. Again Welsbach experimented with all kinds of substances, but to little use; it seemed impossible to improve the incandescent mantle.

In one of his earlies experiments Welsbach had found that the addition of small amounts of thorium oxide to other oxides, like magnesium, lanthanum or zirconium oxide, increased their luminescence greatly, but after fifty or sixty hours' service their intensity gradually diminshed until it was about the same as when no thorium had been added. This falling off suggested the thought that thorium had not been sufficiently investigated scientifically; in other words, that thorium was not a true element. A considerable quantity of raw thorium oxide had come into the possession of Welsbach with the purchase of the Atzgersdorf laboratory. With this he set to work; incidentally improving the methods for preparing rapidly large quantities of thorium salts in a state of purity. His surprise may be imagined when he found that the purer the thorium oxide was, the less light did it give out. The impurity causing the luminescence was looked for in the solutions from which the purest oxide had been obtained and subsequently was identified as a cerium compound. The synthesis of the mixture of 99 per cent. thorium and 1 per cent. cerium oxides, giving a maxium luminosity, was comparatively easy to determine, and resulted in the brilliant light so familiar to all.

Welsbach made this discovery in October of 1891. At that time the value of patents for incandescent mantles had dropped to a minimum and it was high time that the new light came if its few faithful adherents were not wholly to disappear. In an incredibly short time the new mantle swept the entire field of gas illumination.

The demand for thorite, and minerals containing thorium, became very great. Prices rose rapidly and a veritable thorium craze—like gold fever, ensued. Unfortunately on the strength of a faulty analysis or otherwise, a rumor gained ground that a rather common mineral, probably rutile or titanite, contained thorium. Agents of German firms were sent to Norway and Sweden to buy every obtainable quantity of it, paying in some instances as much as twelve dollars a pound for it. The news spread like wild-fire along the coasts of Sweden and Norway (Arendal, Krageroe, Brevig, Hetteroe, Bastnas, Ytterby). People who had not a copper dreamed of coming into thousands. Men and women, little boys and girls, almost anyone who could swing a hammer, pounded and chiseled away in the most inconceivable places. Stones were torn from walls and buildings. Small desolate islands of solid rock rose enormously in value. One woman sold the ballast stones of her washing mangle for several hundred crowns. Even learned professors took advantage of conditions and sold some of their thorium specimens and preparations to defray the expense of special costly investigations.

The reaction, however, soon set in, when the mineral erroneously thought to contain thorium was no longer marketable. As of old, thorium minerals had laboriously to be sought for and collected. In spite of the great demand, the price of thorium minerals began steadily to decline. Orangite, thorite and monazite, which at one time brought $150, $125, and $20 respectively per kilogram, a few months later could be purchased for one-sixth of the above values. This phenomenon is not added as a novelty; it is merely history repeating itself. Whenever there is a sudden great demand for a mineral because of its extended application in daily life or to an industry, its price rises rapidly. Every energy is then put forth to seek it and behold! it is found either in unexpected places in large quantities, or old deposits are opened up and developed profit-

able. Thus it was with the nitre beds; so it was with the natural phosphate fertilizers; so with petroleum and with gold, and so it was with thorium.

The thorium minerals which had almost exclusively been found in Norway and Sweden, and then in but comparatively small quantities, were discovered in the gold fields of Brazil and Australia, in the Ural Mountains and in the United States. Nature had deposited enormous layers of monazite sand in these countries, and thousands of tons found their way into the various laboratories which had sprung into existence to supply the demand for mantles. In a very short time, rather to the surprise of the scientific world an industry of the rare earths was developed, and soon thousands upon thousands of mantles took the place of the ordinary fishtail and argand burner, giving not only more light, but using only one-fifth of the amount of gas for the same illumination.

The treatment of such large quantities of monazite sand, essentially for the thorium oxide, of which it contains from 1-10 per cent., incidentally involved the production of a large quantity of waste material. Only a small amount of the cerium oxide present (50 per cent. or more in monazite) was purified, for, as we have seen, the suitable composition for a mantle is 99 per cent. thorium oxide and only 1 per cent. cerium oxide. While the impure raw material was not thrown away, few mantle works undertook to separate and purify the constituents. It is to the credit of America and American research that the American Welsbach Company at Gloucester City, N. J., under the direction of Waldron Shapleigh, was the first to place large quantities of the various rare earths and their products in unexcelled technical purity upon the market. A French firm near Paris, and a German firm in Saxony, now also produce very pure rare earth compounds.

Aside from thorium, no very great technical uses have as yet been found for the rare earths and their compounds. Yttrium, ytterbium and zirconium oxides find application in the Nernst lamp. Zirconium, the metal, owing to its very high fusing point, has made it possible to produce an incandescent filament lamp with a rating of 1.3 watt per candle-power which exceeds that of the very econimical tantalum lamp by one-half watt. Zirconium oxide, with its high fire-resisting qualities, promises to open up a new and interesting field of investigation in ceramics. Pure cerium oxide has been found useful as an oxidizing agent in the dyestuff industry; while impure cerium oxide has been applied with great success to the modern flaming arc light, in which the carbon rods are impregnated, or the cores filled, with this oxide. In comparison with the constantly increasing amount of material at hand, these uses are very small indeed. Since, however, pure starting material can now be obtained, investigation in this interesting rare earth field is much simplified and offers most excellent opportunities for the young chemist.

Acetylene Burners

By Arthur Bray.

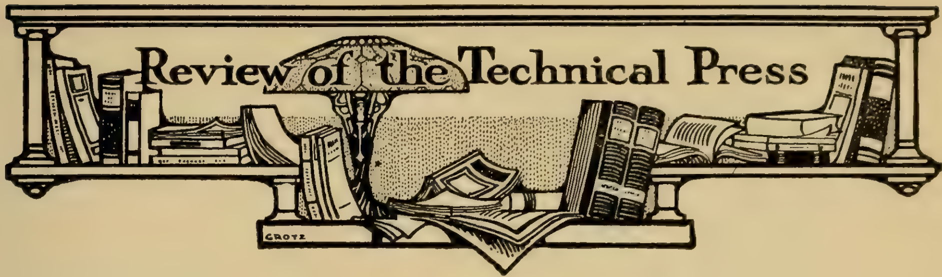
Abstract of paper read before the Acetylene Association, London.

The invention of the air-injecting acetylene burner marked an epoch in the history of lighting by acetylene, and the whole acetylene world hailed it as the end of all their burner troubles. The new burner certainly did eliminate a number of the troubles which early users of acetylene experienced, but it brought others in its train. It will be as well to mention here some of these troubles. The first air-injecting acetylene burners were mounted, as is well known, in a horseshoe-shaped metal socket. This burner certainly had a very much longer and useful life than the Union Jet flat flame burners heretofore used. This extra lease of life extended in some cases to hundreds of hours, but in the end they all suffered the same fate and began to "carbonize." One of the aspects of so-called "carbonisation" will be dealt with later. The next complaint leveled against the horseshoe burner was that, by continual heating and cooling of the burner, the metal arms of the socket "warped" and threw the jets of flame out of alignment. This alleged "warping" will also be dealt with later. The third complaint, of which generator manufacturers will have a lively remembrance, was that users of the new illuminant had become accustomed to the use of coal gas, and would, in spite of every warning, insist on turning the flame of acetylene burners down to a small jet when the full light was not required. The result, of course, being that the burner tips became covered with a deposit of carbon, and when the light was turned on full again, unless it was immediately extinguished, the room in which it was being

used became covered with soot. With your permission, the third of these complaints will be dealt with first.

The other two complaints may be dealt with together, as the results in each case arise from the same cause. It is not intended in this paper to go into matters which are highly scientific, the object of the paper being to give some of the results obtained, and discoveries made during many years' experience in gas burner manufacture. To continue after this small digression—when it was found that the newly discovered air-injecting burner still carbonized after varying lengths of life, many were the abstruse and highly scientific reasons which were put forward to explain the cause, many of them, no doubt, partially correct, but none of them got to the root of the matter. The writer has no hesitation in saying that the main cause of air-injecting burners carbonizing is some obstruction at the point where the gas enters the minute gas passage, that is to say, the underneath side of the tip. This obstruction checks the speed of the gas jet, and prevents it taking a sufficient quantity of air into the mixing tube, consequently there is improper combustion, and so, carbonization. The obstruction often distorts the flame, but not necessarily always. This obstruction is sometimes caused by some particles of metal left by a careless plumber after tapping out the gas bracket. Sometimes it is caused by small particles of dust in the gas pipes being carried along by the gas. But the majority of cases of obstruction are caused, as is now well recognized, by impurities in the gas, caused sometimes by faulty generation. A great many of these impurities have been of late years removed by washing and purifying materials of one sort and another. But burners have been found to become choked even when good methods of generation have been employed, and the gas has afterwards been purified. The writer and his father, the late Mr. George Bray, and his brother, Mr. John W. Bray, were very much troubled at one time during experiments by burners becoming blocked up after some hundreds of hours' constant use, and they therefore determined to try to get at the cause, and eventually collected enough of the obstruction of a great number of burners, and, on the same day that they were going to have them analyzed, were fortunate enough, when disconnecting a sharp elbow in the acetylene fittings, to come across a considerable quantity of flaky white crystals, which they subsequently found in other sharp bends in the installation. The substance which was scraped off the burner tips, and the crystals which were found in the sharp bends of the pipes were then analyzed, and to their astonishment they found that the substance in each case was ammonium chloride.

Now, as to the metal armed burners "warping." When the firm with which the writer is connected took up the manufacture of air-injecting burners, some 10 years ago, they experimented in all kinds of materials to discover which was the best to use, and came to the conclusion that, taking everything into consideration, metal armed burners with enamel tips was the most satisfactory way of making an air-injecting acetylene burner. The main reasons for this decision were that burners made entirely of steatite or enamel became so hot that the jets of acetylene became polymerized, which polymerization reduces the lighting power, and, by aiding the afore-mentioned obstructing process, shortens the life of the burner. The metal armed burner conducts the heat away quickly to the gas fittings, and so keeps, comparatively speaking, cool. The difference in temperature may be readily tested by putting a metal armed burner and a steatite burner on a bar side by side, lighting them, and after they have been lighted three minutes, take hold of the metal armed burner, and, although it is hot, you will be able to bear your fingers on it for a considerable length of time. Now apply the same test to the steatite burner, but it may be as well to give a warning here to anyone who may be thinking of making this test, not to nip the steatite burner, or they will at once have the skin taken off their fingers. Most of the text-books that we have of acetylene mention the "warping" of metal armed burners, but it is probable that the later writers have followed the earlier ones in making this statement. As a matter of fact, in nearly 10 years' experience of metal armed burners, the writer has never come across a single case where a metal armed burner was warped by the action of the heat of the flame as alleged. There have been people who have written saying that the burners warped, and the reply to these people has always been, "Please use a cleaning needle, and clean out the small gas holes in the burner, and if the burner is still 'warped,' please send it on." And in no case has a single warped burner been returned. Full justice cannot be done to a subject like this in a short paper, but it is hoped that its contents may be of some interest.



American Items

Arc Lamps for Car Illumination; their Distribution and Characteristics; by Alfred L. Eustice: *Electrical World.*

The writer states that "the use of electric lamps for illuminating railway cars has been on the increase for some years," which will doubtless be news to most of our readers. The public having at last generally extricated itself from the frying pan of the smoky oil lamp, is it now to be pitched into the fire of the electric arc? The gods forefend! The writer further states that "the electrical engineer, in meeting the constant demands of the public concentrates his efforts along the lines of more efficient illumination." It is really the public, then, that is clammering to get into the fire! The system described consists of the adaptation of a regular type of lamp fitted with a special type of opal shade, the lamps being run in parallel from the storage battery placed in a compartment under the car.

Editorials:

Electrical World: Progress of the New Incandescent Lamps.

The Illuminating Engineering of Small Residences. Passenger Car Lighting. Determining the Mean Horizontal Intensity of Incandescent Lamps.

Electrical Review:
The Speed of Flicker Photometers.
Specifications for Street Lighting.
The Central Station:
Lighting the City.

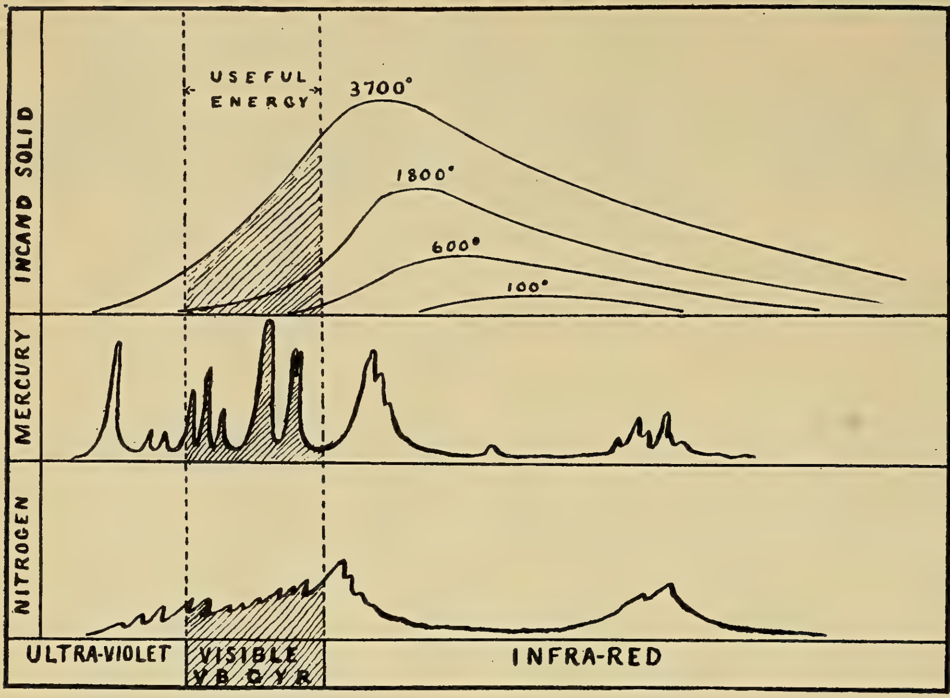
The Relative Efficiency of Light Sources

By E. Percival Lewis.

From The California Journal of Technology.

There is a tremendous waste in two of the most common transformations of energy—that from heat into work and that from heat or electrical energy into light. In heat engines 80 to 90 per cent. of the energy developed is wasted, and in lighting the loss is usually even greater. So inefficient are the usual methods of illumination that a rich reward may be expected by one who can show how to save an additional 2 or 3 per cent. The object of this article is to explain briefly the nature of the problem, to indicate the direction in which progress may be expected, and to describe some of the recent improvements in methods of lighting.

All the sources of light now used may be divided into two classes, one embracing all solid radiators made incandescent by high temperature, the other gases or vapors made luminous by the electric discharge. To the first class belong the incandescent lamp; the carbon electrodes of the arc light; candle, lamp, and gas flames, in which the luminosity is due to finely divided particles of suspended incandescent carbon; and the Welsbach burner, a filmy fabric of oxides of the rare earths, raised to a high temperature by a gas flame.



To the second class belong the flame or arc of the arc light, consisting of luminous vapors of carbon and its compounds or of metallic constituents of the electrodes; the mercury arc and vapor lamps; and various other forms of "vacuum" tube. The luminosity in these cases appears to be directly due to electric disturbances or to chemical reactions. It is doubtful whether any gas or vapor can be made strongly luminous by high temperature alone.

In comparing sources which give a satisfactory quality (color) and intensity of light, it is evident that the most important practical element to be considered is the first cost and the length of life of the sources and the cost of their maintenance. In considering this aspect of the problem we are dealing with what may be called commercial efficiency. There is, however, another type of efficiency demanded, based on purely physical principles, that is no less important, which may be called luminous efficiency. By this is meant the ratio of the luminous energy to the total energy radiated by the source. Carbon heated to 2000 degrees emits an intense white light; nitrogen heated to the same temperature gives out no light. We shall see that nitrogen may be made luminous in other ways, and that its luminous efficiency is then greater than that of carbon; but it costs more to make the nitrogen luminous, and hence it is commercially less efficient than carbon. The problem is to find sources which combine both luminous and commercial efficiency.

In order to get a clear conception of the luminous efficiency of different sources, let us imagine the light from each to be drawn out into a spectrum by a prism. The eye perceives only the colors from the violet to the red; but a photographic plate placed beyond the violet or a sensitive thermometer placed beyond the red will show the existence in these regions of radiations respectively more and less refracted by the prism than the visible colors. For the end in view these radiations are wasted, as they contribute nothing to luminosity.

A very sensitive thermometer, or better still, a thermopile or bolometer, if blackened will absorb practically all the radiant energy falling on it in any part of the spectrum. The resulting temperature changes will be proportional to the energy falling on the instrument. If, starting beyond the violet, we plot distances toward and beyond the red as abscissæ, and the corresponding temperature changes as ordinates, the curve drawn through the ends of the ordinates is called the energy or

intensity curve of the spectrum, and clearly shows the distribution of energy. The total area included between the curve and the axis is proportional to the total radiant energy of the source, including all wave lengths, and the area lying between the violet and the red is proportional to the luminous radiant energy. The ratio of these two areas is the luminous efficiency.

A number of such intensity curves are shown in the figure. Incandescent solids give continuous spectra, with smooth intensity curves. The radiation from a solid at 100 degrees is all non-luminous; at 600 degrees, or red heat, some visible radiation appears. The luminous efficiency for both temperatures is practically zero. At 1,800 degrees, which is approximately the temperature of a lamp flame or the filament of an incandescent lamp, all the visible colors are emitted and the source is said to be white hot; but that part of the curve lying between violet and red includes only about 5 per cent. of the total area (more or less according to the current used); 5 per cent. is the luminous efficiency. The highest curve is that of the positve carbon of the arc light, at a temperature of about 3,700 degrees. In this case there is some ultra-violet radiation. There is a general shift of the maximum radiation toward shorter waves, and the efficiency is 10 per cent. or more. Such curves show that with increasing temperature of the source the luminous efficiency rapidly increases; but as it is practically impossible to reach a higher temperature than that of the electric arc, and as all incandescent solids give intensity curves substantially the same as those of carbon, it seems unlikely that we shall ever attain much greater efficiency than 10 per cent. from any solid made incandescent by high temperature. For most purposes the incandescent lamp, with even smaller efficiency, is the most convenient type. Any gain in the efficiency of these lamps will be cheerfully welcomed; an increase to 10 per cent. would cut our lighting bills in two, while leaving a margin of 80 per cent. for improvement.

If, however, we turn to gases or vapors made luminous by the electric current the case seems more hopeful. Such sources give discontinuous spectra. Each gas is a law unto itself so far as distribution of energy in the spectrum is concerned; but in practically every case a much larger proportion of the radiation is luminous than in the case of incandescent solids. This is illustrated by the intensity curves for mercury and nitrogen, the former giving a spectrum composed of detached lines and the latter a series of bands well distributed through the spectrum. In each case there is also a very faint background of continuous spectrum. The various determinations of distribution of intensity are somewhat discrepant; probably the distribution is affected by the intensity of current and other conditions. It appears that from 20 to 40 per cent. of the mercury radiation is luminous, and Professor Drew, formerly of this University, has shown that at least 20 per cent., and probably more, of the nitrogen radiation is effective. This is a hopeful clue, and some progress has been made in this direction in the development of mercury lamps and flaming arcs.

A brief description of different types of illuminants and of some recent improvements is given below.

Ordinary Arc.—Nearly all of the useful light comes from the carbon electrodes, as the flame emits mostly violet and ultra-violet radiation. The luminous efficiency has been rated as from 8 to 12 per cent.; but this and the following estimates are uncertain. The figures given are apt to be too high rather than too low, as some of the total radiation undoubtedly escapes observation and some light is counted as efficient which is actually of little service—that in the violet and the extreme red for example.

Enclosed Arc.—By partially covering the arc with a transparent or translucent enclosure, so that barely enough oxygen is admitted to oxidize the carbon vapor, the rapid wearing away of the carbons by oxidation is prevented, and the life of the electrodes is extended from a few to one or two hundred hours. The commercial efficiency is thus increased. The luminous efficiency is probably not greatly different from that of the ordinary arc, but the light is better distributed.

Flaming Arc.—The flame of the carbon arc has a discontinuous spectrum similar to that of nitrogen, but unfortunately most of the radiation lies in the ultra-violet. If the carbons are impregnated with the salts of calcium and other metals the flame is colored thereby and emits a larger proportion of visible radiation. The carbons emit less light, as their temperature appears to be lowered by the presence of the metallic vapor. The luminous efficiency is high, perhaps 15 per cent. or more, and less current is required to maintain the arc. Unfortunately it is difficult to get just the

color required; the light is apt to be too red or yellow.

VAPOR LAMPS.—The mercury arc was the first vapor lamp seriously tried; but it cannot be used in the open air, because of the mercury fumes, and if enclosed, even if in quartz vessels, the intense heat rapidly deteriorates the enclosing vessel, and the lamps are short-lived. It was found by Cooper-Hewitt that there is much less trouble when the discharge passes through the vapor at low pressure in a vacuum tube. He found that 110 volts or less will maintain a brilliant discharge through such tubes, although the current must be initiated by a spark or arc through the vapor. The light is not so intense as that of the arc, so that large tubes must be employed to give a light comparable with that of the latter. These lamps have a high efficiency, both luminous and commercial, but unfortunately the light is not of an agreeable color. It contains practically no red and a very large proportion of green. So far it has not been found possible to properly temper the light by other ingredients, as other vapors tend to prevent the passage of the discharge at low potentials. The luminous efficiency is said to be 30 to 40 per cent.

To drive the current through nitrogen and other gases and vapors much larger voltage is required than in the case of mercury. In every case so far investigated the total radiation for a given current is small, although a large fraction of it is useful, and no method has been found to make these tubes commercially efficient, because of the great expenditure of energy necessary to excite luminosity. McFarland Moore and others have used such tubes, but it was necessary to make them of enormous size to furnish sufficient illumination.

A similar difficulty prevents the use of phosphorescent materials as sources. The light of the firefly and the glow worm and of various other phosphorescent materials is almost perfectly efficient, as practically all the radiation is luminous—but there is so little of it that such sources are useless.

INCANDESCENT LAMPS, CARBON FILAMENTS.—The methods of preparation have been much improved since the days when carbonized bamboo strips were used. Cotton threads are parchmentized by treatment with sulphuric acid solution, drawn to uniform cross section, and carbonized; or cotton wool is dissolved in zinc chloride solution, and the cellulose solution "squirted" through a small hole into alcohol, which causes it to set in a vermicelli-like form. The strips are then carbonized and partly reduced to graphite by subjecting them to a very high temperature. These filaments can stand more current than the earlier forms and have a longer life, hence there is an improvement in both luminous and commercial efficiency. At ordinary voltages a luminous efficiency of about 5 per cent. is obtained. By running up the voltage an efficiency of about 7 per cent. can be reached, but the lamp will not long survive such treatment. At lower temperatures than that required for white heat the efficiency is very small. An electrical journal recently commended the "wisdom" of companies which prolong the life of their lamps by running their lighting circuits below the normal voltage. This only too general policy may be wisdom for the companies but it is hard on the consumer. A reduction from 110 (normal) to 100 volts will reduce the luminosity of a lamp about 50 per cent. The expenditure of watts per candle-power is, however, increased about 50 per cent., which means that the consumer is paying for that much more invisible radiation; but the lamp lasts five or six times longer.

NERNST LAMP.—Some solids, particularly the oxides of the rare earths yttrium, erbium, zirconium, etc., appear to radiate somewhat selectively when incandescent—that is, there seems to be a greater proportion of visible radiation than in the case of an ordinary solid at the same temperature. The Welsbach burner, made of these oxides, emits a light decidely more green than the light from a flame or carbon filament at the same temperature. The filament of the Nernst lamp is made of such materials.

When cold it is a non-conductor; when raised to red heat by a flame or automatic resistance heater it conducts and becomes brilliantly incandescent. The conduction is electrolytic, so that an alternating current must be used to prevent decomposition. As the filament does not further oxidize it may be used in the open air; all other incandescent filaments must be enclosed in a vessel filled with a neutral gas or exhausted. This lamp can be raised to a very high temperature, so that its luminous efficiency is high, but it has a short life, rapidly deteriorating and becoming useless after 200 to 400 hours.

METALLIC FILAMENT.—Recently many attempts have been made to use the more refractory metals, such as tungsten, tan-

talum, titanium, osmium, and zirconium. In most cases these substances cannot be drawn into wire, so that the filament is prepared by mixing the finely divided metal or its oxides with vegetable binding material, squirting this paste through a small hole, and then heating the filament in a reducing atmosphere. They seem to have a greater luminous efficiency than carbon filament, probably on account of the higher temperature to which they can be raised, although the additional advantage of selective radiation is claimed in some cases. They seem to be a little uneven in their performance, and are short-lived—factors which must be reckoned with in rating their commercial efficiency. The resistance of metallic filaments increases with the temperature, hence they are partially self-regulating with visible current.

"HELION" FILAMENT.—The latest advance is a filament devised by Professor Parker, of Columbia University, to which the name "helion" has been applied, on account of its sunlike light. It is reported to be a carbon filament impregnated or covered with silicon, of great resistance and durability and capable of soldering its parts together at a break. Selective radiation is claimed for it. It is said that it emits white light at a temperature at which carbon is only red hot.

Below is a tabular comparison of the luminous efficiencies and the actual energy in watts expended in maintaining one-candle-power. The figures must be considered as only approximate in most cases. Different observers using different methods obtain results which are not always consistent with each other—and individual sources of the same type differ from each other in performance.

It would be misleading in some cases to rate relative cost in terms of the energy used per candle-power. For example, the 3 to 5 watts required for candle-power in an incandescent light may cost more than the 85 watts (heat of combustion) expended by a candle or the 68 watts expended per candle-power in a gas flame.

It is evident that there is abundant room for improvement and that the most promising field of investigation is that of luminous gases or vapors.

Source.	Luminous Efficiency. Per Cent.	Watts per Candle-Power.
Red hot wire	0	......
Hydrogen flame	0	......
Candle	1-2	85
Oil lamp	2-3	57
Gas flame	2-3	68
Welsbach burner	3-5	......
Carbon filament	3.6	3.5
Nernst	5-7	1.2-2
Titanium	.....	2.5
Osmium	7	1.7
Tantalum	.....	1.9
Tungsten	.....	1-2
Zirconium	.....	1
Helion	.....	1
Arc (carbon)	10-12	0.5 -1.5
Arc (flaming)	12-15 (or more)	0.12-0.25
Mercury vapor tube	30-40	0.25-0.5
Vacuum tube	20-40	......
Sun	34	......

Foreign Items

NEW BOOKS

"A History of the Introduction of Gas Lighting." By Charles Hunt, M. Inst. C. E., President of the Institution of Gas Engineers. London: Walter King; 1907. [Price, 8s.]

In reviewing this book, *The Journal of Gas Lighting* says:

Let us briefly glance through the five chapters which compose the present book. Chapter I. deals with "Early Records," most of which are well known; Thomas Shirley's "Description of a Well and Earth in Lancashire, Taking Fire by a Candle Approached to It," published in the "Philosophical Transactions" for 1667; the definitions of "Gas" by Van Helmont (1577-1644); and in Nicolson's "Dictionary of Chemistry" (1795); Dr. Clayton's letter to Boyle relating "An Experiment Concerning the Spirit of Coals"; Dr. Hales's "Vegetable Staticks"; De Gensanne's first account of the distillation of coal for industrial purposes (1770); Dr. Watson's experiments on coal distillation (1781); the lighting of Culross Abbey by gas from Lord Dundonald's tar-kilns (about 1782), and the first recorded instance of a coal-gas explosion in consequence of it; and Diller's exhibition of his "Philosophical Fireworks" at the Lyceum Theater, London, in 1788. Minckelers (who only has two pages devoted to him) first used coal gas for inflating balloons, and he may have lighted his lecture-room with it in 1785, as is alleged. But Murdoch was the first to demonstrate the utility of gas-lighting, and "the first to show how it could be applied to the use and convenience of man."

Chapter II. is perhaps the most interesting of all in the book—dealing as it does with Murdoch and Lebon. We have presented to us vivid pictures of Murdoch in Cornwall using his Herculean proportions and muscular power to thrash a roomful of mining captains; of his being indefatigably at work, neglecting both food and bed; of his experiments with, and desires to patent, his steam road-carriage; and of Boulton and Watt's anxiety to "cure him of the disorder, or turn the evil to good," as it is quaintly expressed in a hitherto unpublished letter dated September 2, 1786. But we will not spoil the other good and entertaining things in this chapter, but leave them for the reader's enjoyment.

To the following chapter, relating to "Murdoch, Clegg, and Others," we have already referred, containing as it does the inquiry into the Soho Foundry illumination. With Chapter IV., on "Winsor," as has already been remarked, we are rather disappointed; and we are inclined to think that the lengthy extracts from his pamphlets might have been better placed in an appendix. The last chapter records the "Struggle for Incorporation," and Mr. Hunt here brings out clearly the narrowness of the views of Winsor's opponents, although among them were Murdoch and Watt. The author says (p. 136): "The opponents entirely failed to grasp the significance and possibilities of the scheme propounded by Winsor. The idea of a public supply of gas lighting was beyond them; they saw no farther than a gradual extension of private installations. They took alarm at the prospect of the establishment of an incorporated company as likely to interfere with their business." All of which shows how small great men can be, and how history—human and commercial—does not change very much through a century.

In conclusion, we must thank the author for placing at the disposal of gas students —young and old—his valuable researches, and for adding to their interest by giving so many new and interesting photographs and illustrations, which are quite an admirable feature of an entertaining and instructive book.

A New High-Power Gas-Lamp

By C. Richard Böhm, Berlin.

From Journal of Gas Lighting.

The great progress in artificial illumination during the last decade has been accompanied not only by greater efficiency and more convenient manipulation, but also by greater intensity of light. Thus so eager a desire for light has arisen as was never before dreamt of. Since the introduction of the electric arc lamp, every effort has been made to increase the illumination derived from oil and gas, in order to approach, if possible, the great intensity of the electric arc lamp.

With the discoveries of Auer von Welsbach, gas lighting entered upon a new stage in its development—since the well-known

incandescent burners in conjunction with first-rate mantles produce 100 to 120 Hefner candles, and in efficiency have a decided advantage over even the newest metallic filament electric lamps. It is, however, more difficult for the gas engineer to compete with the electric arc lamp. The "Lucas" lamp, which, in the simplest manner, produced with gas a light of 500 Hefner candles, could certainly be compared with the earlier electric arc lamps. But it was bound to succumb before the powerful light-centers of the flame arc lamps of 1,000 candles, such as are now to be seen in all great cities.

The principle of the Lucas lamp was the supplying of a greater quantity of air to the burning gases by the draught produced by a long chimney.

The inventor of the original Lucas lamp has now succeeded in constructing a new high-power lamp depending upon other principles. He has arranged a thermopile in the lamp itself, which is heated by the waste gases, and thus produces free of cost the electric current for driving the fan. The thermopile is connected by leading wires with a small motor in the lower part of the lamp, which on its part is coupled up with a fan.

Fig. 1 shows a vertical section through the important lower part of the lamp.

By means of the pipes which are bent at the top, and enameled white below, and which terminate in the roses D, the gas is led into two mixing-tubes. The armature A of the small electromotor arranged between the poles of two steel magnets runs with a vertical axis on a point in a brass

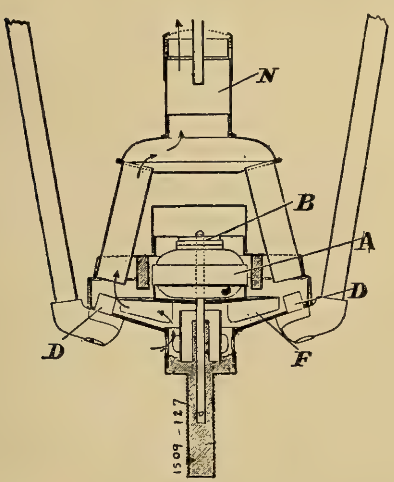


FIG. I.

case filled with oil, in order to avoid friction as much as possible. On the armature a fan provided with six wings F is screwed. The fan sucks up air from below; mixes it with the gas passing out from the roses D; and forces the mixture of gas and air through the mixing-tubes and mixing-chamber into the burner-head N. The hot products of combustion, in rising, heat the inner junctions of the thermopile A, and thereby produce the electric current. The current is led to the two brushes enclosed in the chamber B, which lie by virtue of their own weight on the commutator of the armature.

Thermopiles have been known for a considerable time; nevertheless it was important in this case to choose a construction which might be as convenient as possible and, above all things, durable. There was no need to consider the cost of heating it, for the waste gases themselves provided a source of heat. Lucas uses two metallic alloys for making his thermopile. One of these consists of copper and aluminum; the other of copper and nickel. These alloys, which are capable of withstanding heat to a high degree, are employed in the form of metal strips, which are soldered hard at the heated end and soft at the cool end. The thermopile is arranged in the form of a disc, and can be replaced in a few moments. Just as ingenious are the small motor and fan; so that they are not likely to get out of order even after long usage.

On starting the lamp, it burns at first (the pressure of the gas being, of course, only normal) with a feeble flame of little illuminating power. Presently the hot products of combustion rising in the chimney heat up the inner junctions of the thermopile. The electric current is thus generated, so that the electric motor presently commences to rotate the fan at a high speed. After only about halt-a-minute, it already attains a speed of some 2,000 revolutions per minute, and the lamp then emits a light of 1,100 to 1,200 Hefner candles—consuming about 900 litres of gas per hour.

Professor Wedding has subjected this high-power lamp to a searching examination, and found that it behaves well even in extreme cases, and as a lamp for intense illuminating purposes is far superior to the older compressed-gas lamps. It possesses, moreover, the great advantage that it works without the aid of extraneous apparatus, and can be attached to any ordinary gas installation and set into action at once.

Miscellaneous News

BALTIMORE, MD.—Mayor Mahool has given orders for the abandonment of the city's municipal lighting plant, which was costing the taxpayers just four times as much as the service it gives is worth. The plant was used to illuminate the city hall and the county court-house, and its operation cost $30,000 a year. This seemed such an excessive figure that after many complaints of the cost had been made, an investigation was ordered, and it was found that mismanagement, incompetency and unbusinesslike control was resulting in excessive cost. A private concern offered to do the same lighting as the municipal plant, and for the city hall annex in addition, for $7,500 a year.

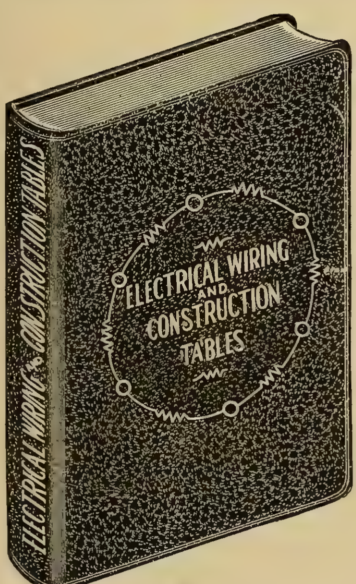
FRANKLIN, LA.—Contract has just been let to Muralt & Co., engineers, of 114 Liberty street, New York, for a complete modern municipal electric light plant for town of Franklin, La. The power house will contain Heine safety boilers, Harrisburgh engines and Fort Wayne electric apparatus. The contract calls for getting out the machinery in three months. Mayor J. C. Lewis, of Franklin, was the moving spirit in getting this plant. The plans and specifications were prepared by Warren B. Reed, consulting engineer, of New Orleans.

NEW HAVEN, CONN.—A reduction amounting to about 12 per cent. in the cost of electric lighting in this city was announced recently by the United Illuminating Company and will take effect August 1. The reduction will be made in the form of a discount to be graded according to the amount of juice used by the consumer. This is the second reduction to be made by the Illuminating Company in a short time.

ST. LOUIS, MO.—President O'Reilly of the Board of Public Improvements has announced that plans for a municipal lighting and heating plant for the insane asylum, poorhouse, female hospital and one or two other city buildings comprising a group in the south end of the city, are nearly ready. The plant is to be the first real municipal lighting plant in the city. The plant will cost over $150,000 and will probably be separate and apart from all the institutions which it is proposed to accommodate. All three of the institutions named are now being lighted by contract, and the expense to the city is considerable.

SOUTH NORWALK, CONN.—From a close scrutiny of the fourteenth annual report, for the year ending January 1, 1907, the municipal electric plant of South Norwalk, Conn., appears to be conducted with a fair measure of success. It supplies a commercial as well as a street lighting service and is honored with a general superintendent, Mr. Albert E. Winchester, who is regarded as a man of exceptional ability. With reference to street lighting no very striking claims are made. The plant supplies 109 direct current series enclosed arcs which "are lighted from dusk to dawn, except when there is sufficient moonlight to render the service unnecessary; however, no regular moonlight schedule is followed. Saturday evenings the streets are lighted regardless of the moon." The average hours per lamp per year is given as 3,287, against the approximate 4,000 hours of an all-night and every-night service. The department after claiming to have made allowances for depreciation and interest, but none for loss of taxes, estimates the average cost per lamp per year at $60. This would be more than $70 for an all-night every-night service. The report is much more complete and interesting than the ordinary products of municipal plants.

Macbeth-Evans Glass Company,
Pittsburgh,
Manufacturers of all kinds and colors of
Illuminating glassware,
Alba glass for diffusion,
Thermo glass for high temperature lamps.



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1st. Annual Convention
Illuminating Engineering Society 1907.

THE ILLUMINATING ENGINEER

Vol. II. AUGUST, 1907 No. 6.

Outline Lighting in Lincoln, Nebraska

By T. B. Mitchell.

There is no small degree of rivalry among our Western cities in the matter of electric illumination. A great deal of civic pride has been aroused among merchants and business men, and even the residents themselves are anxious to have their town known as "the best lighted city of its size in the United States." Whether or not Lincoln can justly make this claim will be better left for your readers to judge. We do claim, however, and believe

FIG. I.—HERPOLSHEIMER'S DEPARTMENT STORE.

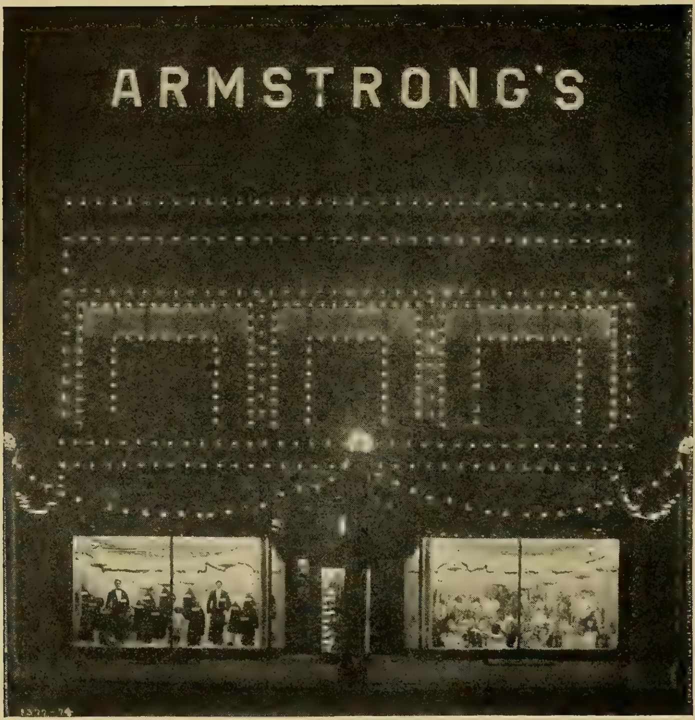


FIG. 2.—ARMSTRONG'S CLOTHING HOUSE.

that the few examples here shown will prove, that our city is, at least, not far behind in the race, and it will not be the fault of the lighting company in its efforts, nor of the citizens in their response, if Lincoln does not stand at the head of cities of its class in this respect.

Figure 1 shows one of our largest department stores. The building was originally one of the State Fair Buildings, and it will be observed that the daylight illumination is uncommonly well provided for, as well as its artificial lighting. One of our men conceived the idea that it was an uncommonly good subject for outline lighting and presented the matter to the proprietors, who at once fell in with the idea. They find that it more than pays from an advertising standpoint, and even use a cut of their store, similar to the illustration, on a souvenir post card.

Figure 2 shows one of the largest clothing stores in this section of the country. Armstrong's motto is "Light and Lots of It," and he uses it as lavishly on the inside as for display purposes on the outside. The outside lighting is equivalent to 800 4-c.p. lamps and is run every night in the year until midnight. It is turned on and off by our own night watchman, and we watch the lamp renewals very closely.

Figure 5 shows a number of small stores on Post Office Square. The lighting for both windows and outlining is burned every night in the year until midnight. The contracts are all on a flat-rate basis, the service being controlled by us with lock switches.

Figure 6 shows a hotel two blocks

FIG. 3.—LYRIC VAUDEVILLE THEATER.

FIG. 4.—LYRIC THEATER, INTERIOR.

FIG. 5.—A GROUP OF SMALLER STORES.

from the main street. The exterior lighting is on a flat-rate basis, and is burned nightly until midnight. Some weeks ago an accident occurred to their sign, and the management worried the sign-maker nearly to death in order to get it repaired immediately, as they claimed they lost many dollars nightly on their transient trade because of not having the sign in operation.

Figure 3 shows the exterior of a ten-cent vaudeville theater. So thoroughly convinced is the management of the value of display lighting as a business getter that they say that "for every spot they leave dark on their building, they are losing a dollar." They not only believe in attracting patronage by exterior display, but by giving their patrons as good illumination within as without, as Figure 4 will show.

Altogether we have about 15,000 4-c.p. lamps used for display lighting alone, and nearly every store window is brilliantly lighted until midnight. We furnish free wiring on two-year contracts only for this class of lighting.

FIG. 6.—WINDSOR HOTEL.

Glimpses of Street Lighting from Buffalo to San Francisco

By H, T. Owens.

"We have abandoned the use of gas for the lighting of our streets, using electricity exclusively." This statement may be noted in numerous pamphlets issued by the Boards of Trade of many enterprising cities.

On a trip from New York City to the Coast and return, taken during May and June of this year, the writer visited a number of the cities which boast the best, or the newest, in street illumination.

Buffalo, N. Y. From the Lehigh Valley R. R station the contrast looking south and north is very great—single enclosed arcs, probably 600 feet apart to the south, while in the other direction twin enclosed arcs (clear outer globes in both cases) on handsome poles, placed opposite to each other, and about 125 feet apart. The residence district is lighted by means of enclosed arcs, obsolete open flame gas lamps, and a few mantle gas lamps.

Chicago, Ill. The open arcs, and the condition in which they are kept,

FIG. I.—BUFFALO.

FIG. 2.—ST. LOUIS.

FIG. 3.—SALT LAKE CITY.

FIG. 4.—DENVER.

should be a lesson to all advocates of municipal ownership.

Denver, Col. The lighting of Sixteenth Street has been so highly praised that a word of criticism may not be amiss. The lamps are all that could be desired, but the posts are of such dimensions that the property-owners may sue to recover damages, owing to loss of daylight and air. Enclosed arcs with opal outer globes are used on "show" streets, and open arcs in the residence district. Denver may well be called "The City of Lights," both good and bad.

Salt Lake City, Utah. The broad streets of this beautifully located city are overshadowed by all kinds of electric wires. When the poles along each sidewalk have their full complement of wires, poles are then erected down the center of the street. Enclosed arcs placed above the network of wires and about 800 feet apart furnish what illumination there is.

San Francisco, Cal. With an earthquake and fire only a matter of one year ago, and a labor war a momentous question of to-day, it is necessary to state only that the enclosed arcs and mantle gas lamps were in evidence, although sadly in need of repairs.

Sacramento, Cal. Open arcs; no comment necessary.

Monterey, Cal. The street—for it

FIG. 5.—SAN FRANSISCO.

FIG. 6.—LOS ANGELES.

has only one—that has the distinction of having sidewalks, is lighted with enclosed arcs. Some of the byways have incandescents. The contrast between the exterior and interior illumination is noticeable, for the majority of the stores have high efficiency frosted bulb incandescents with prismatic reflectors, and "The Hotel," with its ceiling, domes, etc., has an installation of which any one would be proud.

Los Angeles, Cal. This, the best advertised city in the United States, may some day be entitled to be called the best lighted, if present indications mean anything. There are nearly 600 ornamental incandescent lamps in the center of the city. They are placed opposite each other and about 120 feet apart. The posts are very handsome, and the illumination is soft and well diffused, and compares favorably with the best that Paris, London, or New York has to offer. Unfortunately no further comparisons are possible, especially with the first named city. The outline lighting of the Alexandria Hotel is a notable feature of the show district of the city. Outside of this zone enclosed arcs with clear inner and no outer globes are used. The reason for the clear inner globe is that the dust soon causes the inner globe to appear opal and give a similar illumination. Lamps are suspended from wires at the center of each street intersection, as additional poles would be an absurdity, there being two telephone, two telegraph and three electric light companies operating with overhead wires. As some of these

FIG. 7.—PASADENA.

arcs which are lighted on gala occasions.

Kansas City, Mo. Here one has the opportunity of comparing the luminous and the enclosed arc. The amount and quality of the illumination produced by the former are superior. Numerous mantle lamps may be seen, but they are not placed so as to produce an even illumination.

FIG. 8.—MONTEREY.

residence blocks are 800 feet long, and as the arcs are placed only at the intersections, there is no illumination on a considerable portion of the street.

Oakland, Cal. The conditions here are similar to those at Los Angeles; there are ornamental incandescent lamps and enclosed arcs.

Pasadena, Cal. The ornamental incandescent lamps here are decidedly original, and comparatively inexpensive, twelve bulbs in small glazed globes hung pendant, and one larger globe upright. In the day-time the effect is not pleasing, but at night you are in a fairyland of lights, which are in keeping with Pasadena's claim as being "the most attractive city in this country." Some illumination is furnished in the residence districts by bare incandescents.

San Jose, Cal. Enclosed arcs furnish the illumination, here the feature being an electric tower 300 feet high, at the top of which are placed four

St. Louis, Mo. Enclosed arcs on handsome poles in the business section, and mantle lamps in the residence district, furnish the illumination of a well-lighted city.

The most striking point about the illumination of the different cities visited was the contrast. The latest and most approved types in one portion of a city, and an inefficient, obsolete type, or perhaps none at all, in another.

At a recent dinner given in New York City one of the speakers stated that the architects should pay more attention to designing lamp-posts than libraries. This is very true, if we are to lead the world in street lighting.

Theory and Technology

Plain Talks on Illuminating Engineering

By E. L. Elliott.

X. Fixtures

The illuminating engineer must, to a certain degree, be an artisan. An artisan is one dealing with handicrafts in which there is an application of art. There is a very distinct line of demarkation between the artisan and the artist, which, in spite of its distinctness, is frequently overlooked. The work of the artist is its own reason for existence, appeals to the æsthetic nature alone, and is distinct from all considerations of utility; while the work of the artisan consists in applying the artistic to the useful, or making the useful beautiful, and is, therefore, limited to such forms of artistic treatment as will not interfere with the utilitarian purpose of the objects or material worked upon. The illuminating engineer would not naturally look to Emerson for rules of practice; yet the following quotation from the philosopher will form a safe and succinct guide in all matters which touch the artistic side of his work:

We ascribe beauty to that which has no superfluous parts, which exactly answers its end.

It is plainly not the province of the illuminating engineer to create artistic designs, either for fixtures or other lighting accessories; it is, however, quite within his prerogative to exercise a veto power, within reasonable limits, upon the artisanship of others, and for this reason he should be sufficiently familiar with the fundamentals of decorative art to distinguish between what is essentially good, and what is positively bad. The artisans whose work he comes in contact with, including the architect, decorator, and fixture designer, often make the mistake of considering themselves artists, *i.e.*, of placing the æsthetic value of their work above its utilitarian purpose. There is often no more difficult problem confronting the practicing illuminating engineer than this one of keeping a proper balance between the supposedly artistic and the necessarily utilitarian features of illumination. Besides being an artisan, an illuminating engineer must often be a diplomat as well; in fact, the numerous virtues required to make a complete illuminating engineer are little short of those of a universal genius.

A lighting fixture consists essentially of two parts, namely, the mechanical arrangement for supporting the lamps and for conducting the illuminant to them; and second, the accessories used for diffusing and distributing the light. The most common materials are metal for the former, and glass for the latter, although varia-

tions of this scheme are possible. The dictates of mere common sense would require that the supports for any object should have a due proportion to the weight supported, and no assumed demands of art can counteract the normal action of the mind in recognizing this sense of proportion. All devices for generating light are comparatively light in weight. The ordinary electric lamp weighs an ounce, while a gas tip weighs less than half

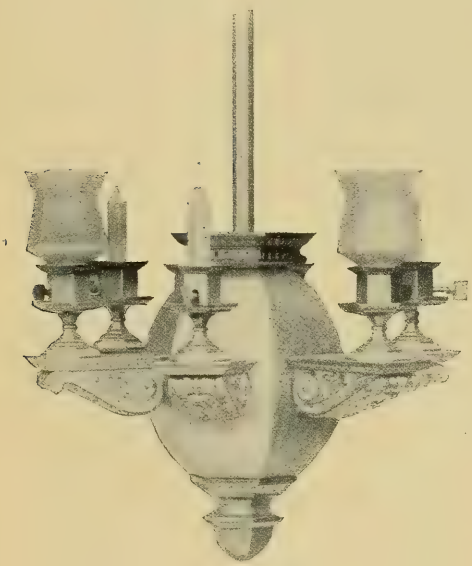


FIG. I.

as much, and an incandescent gas burner but a few ounces. Not only are they actually light in weight, but appear so. To be sure, the accessories in the way of globes and shades may weigh considerably more, but at most never exceed a few pounds. The gross absurdity of using hundreds of pounds of metal to support as many ounces in weight can never be justified by the inner consciousness by any amount of argument. The chandelier shown on page 457 is a good illustration of this error. The fixture weighs 1,500 pounds and requires a 90-pound railroad rail in the ceiling to support it; and all this to support a weight of lamps and globes which probably does not exceed 40 pounds. The illustration (Fig. 1) shows the same fault. Of course, the metal parts are hollow, but so far as the eye is concerned they are all solid. The elements of the design are those used in the heaviest of building constructions; the arms are braces which might support the steel girders of a "skyscraper." It furthermore transgresses the purpose of illumination by affording a large surface to intercept the downward light.

Figure 2 shows a side bracket which is open to the same criticism. In addition to the clumsy support, which is a bracket that, at least so far as appearances go, might well sustain the truss of a ceiling, the electric lamp sockets are presumably floating upon the oil contained in the urn, which supplies the central wick, which in this case happens to be a gas jet.

This tendency to use excessive quantities of metal is perhaps the most common fault which the illuminating engineer will be called upon to modify. It must be remembered that the fixture manufacturer is a metal dealer, and is only following the natural instincts of business when he puts all the metal possible into his wares. The fixture designer and manufacturer, and even the architect, will usually argue that the fixture must be "massive" in order to preserve a due proportion to the surrounding architecture; but this argument will not stand analysis. A fixture does not support the building, nor any part of it, either actually or apparently; in fact, it is not a part of the building, properly

FIG. 2.

in many cases, of distinguishing between metal of paper-like thinness, cleverly stamped and drawn, from substantially wrought plate or castings. Gilded spelter defies detection when hung up out of reach. Many a chandelier gives one a sense of fatigue (a scientific way of saying that it makes one tired) to observe the painful effort which it is constantly making to support its burden of globes and burners at the ends of its tenuous, wavering, outstretched arms, the globes often careening over to the side in token of the excessive strain. In addition to this legitimate burden there is often an additional weight of filigree jimcracks, which are presumably intended to distract the attention of the observer from the constitutional weakness of the fixture. Figure 3 shows several examples of this familiar type.

speaking, but merely a necessary auxiliary for a specific purpose, and this purpose declares itself so plainly as to entirely separate the fixture from the general architectural construction. The fixture installation of the Pennsylvania State Capitol must remain as the monumental example of this fallacy. (See description in issue of Dec., 1906.)

The opposite fault, however, of a light and flimsy construction is by no means unusual. Longfellow wrote a stanza which runs thus:

In the elder days of art
  Builders wrought with greatest care
Each minute and unseen part,
  For the gods see everywhere.

When the gods take a look at the minute and unseen parts of many lighting fixtures, what a cynical grin must overspread their countenances as they behold the deception perpetrated upon present-day mortals. Ordinary vision gives no means of judging the thickness of a brass tube, nor,

FIG. 3.

In point of artistic treatment, the most conspicuous feature of the average American fixture is its hopelessly stereotyped appearance, and woeful lack of originality. As a matter of fact, the fixture is usually a collection of various stamped and molded pieces which are "kept in stock." Rarely

does the designer show any conception beyond a mechanical imitation of the torch, which was the light by which our prehistoric and savage ancestors illuminated the caves in which they fought with each other for bones; and the candle, which was the light by which Moses wrote the Pentateuch. The limitless possibilities of the electric light have scarcely been touched, much less generally realized and applied in fixture designs. The ordinary American lighting fixture of the present time bears about the same relation to the artistic possibilities of which it is capable, as the chromos which passed current fifty years ago bear to the best modern reproductions of the master pieces of art. Of course, we are a young nation yet, and cannot be expected to have attained to all of the grace and refinements of life that are found in the older countries of Europe. It is encouraging to note that we are progressing in this respect, and it is not unreasonable to hope that, in art and artisanship, America may yet come to the front as she has in the practical utilities of life. Our grandchildren may have really artistic lighting fixtures of domestic manufacture.

The following illustrations show a number of examples of European fixtures taken from the Manufacturers' Catalogues. They are therefore not special designs but regular "stock" and will give some idea of the foreign conception of construction and decoration. A number of points are worthy of observation. First, the simple fixtures have a beauty of outline and a general gracefulness of design which are especially noteworthy in contrast to the stiffness and awkwardness of the average American fixture. Another feature which will strike the American observer is the use of flexible cord in electrolier construction. This construction is of a kind which unequivocally declares itself to be electrical; neither gas, nor oil, or any other luminant can be trans-

THE FIXTURE AT THE LEFT AND THE ONE IN THE CENTER ARE OF WROUGHT IRON CONSTRUCTION, AND ARE GRACEFUL AND WELL PROPORTIONED. THE CHANDELIER AT THE RIGHT IS OF GILT BRONZE, THE LOWER PART FASHIONED OF HAND-BLOWN GLASS.

AN EXAMPLE OF ART NOUVEAU, IN HAMMERED COPPER, WITH THE LAMPS PENDANT FROM FLEXIBLE CORDS.

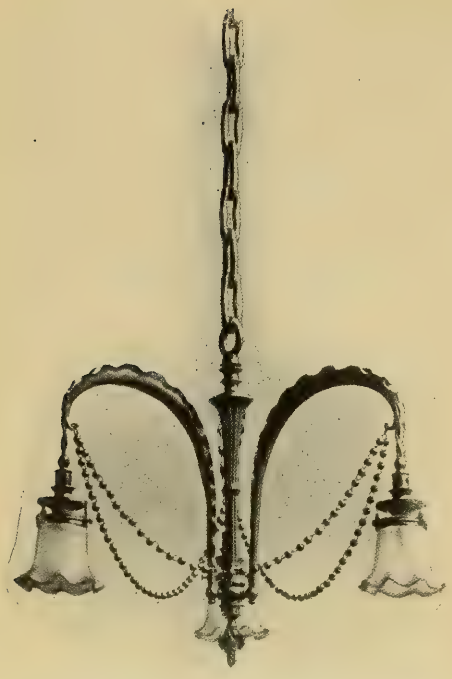
mitted through wires or cords. Such construction would at present run afoul of underwriters' regulations in this country, but it would be quite possible to make a flexible cord having a steel wire strand twisted in, by which to support the lamp and shade, leaving no strain upon the conduits. This would also give the cord a much more substantial appearance, which is the one weak point of the fixtures shown. There is a flexibility and grace about such a construction which is absolutely impossible with any form of metallic tube or rod. Lastly, it will be observed that the examples shown are good from the illuminating engineer's standpoint, having the lamps well placed for the distribution of light; and in a more ornate example the ornamentation does not obtrude itself as a wholly unnecessary addition to the fixture, but is rather an integral part of the construction.

Besides exerting a possible "moral influence" upon the artistic design of the fixture, the illuminating engineer will often be called upon to specify the mechanical construction. He must be, therefore, conversant with details of construction sufficiently to protect his client against errors and frauds. The several points to be considered are: strength, proportion, materials, and design.

As to strength, the possibilities of

A FLOWER-LIKE DESIGN OF THE ART NOUVEAU TYPE, WITH A LIBERAL USE OF MODERN ART GLASS.

deception in this regard have already been mentioned. The gauge of tubing, and the proper weight or thickness of all essential parts, should not be left to chance, or to the manufacturer's choice. The tubing used for arms of chandeliers and brackets is often so light as to be readily twisted out of shape in putting up or cleaning; fixtures with their arms akimbo in the most dissipated fashion are familiar objects. This is particularly to be avoided in gas fixtures, since a little tilting of an incandescent gas burner will throw a flame against the chimney, with fatal results to both mantle and chimney. Shade holders are an-



A SIMPLE, GRACEFUL, AND INGENIOUS FIXTURE FOR USING INVERTED GAS BURNERS.

other part in which strength is of importance. Many of those on the market are entirely inadequate to hold a pressed glass globe safely, especially at an angle.

Proportion has to do with both the constructional and artistic design. The excessive use of metal, so deprecated in treating of the artistic side, may very readily prove an unsafe burden upon the mechanical supporting parts of fixtures. In the investigation of the furnishing of the Pennsylvania State Capitol, it was shown that many of the fixtures were an actual menace to the occupants of the building by reason of their enormous weight and ill-proportioned construction.

As to materials, there are opportunities for both error and fraud. The high degree of perfection to which electro-plating has been developed makes the term "bronze" a very elastic one; like other forms of beauty, it may very readily be only skin deep. Plating and gilding are perfectly legitimate process, and in many cases are even preferable to the use of solid materials; the point is to see that they are not used where solid material is required. Steel pipe in place of brass is a construction sometimes used, and is entirely satisfactory where a wrought iron or dark bronze finish is to be used. Lighter finishes made by plating are not so satisfactory as those made on brass. Spelter, which is a very soft brass, must be avoided where any degree of strength is required, and

A QUAINT WALL BRACKET FOR INVERTED GAS BURNERS. NOTE THE TWISTED BRASS TUBES TO IMITATE FLEXIBLE ELECTRIC WIRES.

is admissable for ornamental designs only where cheapness is essential.

By design we refer to the number and arrangement of the lamps and their accessories. With the ordinary forms of globes and shades it makes little difference so far as distribution of light is concerned, what the position of the light-source is within them; but now that prismatic shades

and reflectors have become a standard article, and since their advantages from the engineering standpoint are so positive, the matter of the correct position of the light-source becomes an item of marked importance. This is particularly true in a case of reflectors. A variation of a half inch in the position of the light-source will change the distribution curve in a very marked degree; and in a prismatic globe a variation of two inches might almost nullify the whole advantage to be gained. As an example of the utter disregard of accuracy and mechanical construction observed by the average fixture maker, we recall a case in which a fixture specified by an illuminating engineer was found not to be in accordance with the specification. When the maker's attention was called to it, he replied that he could not be expected to attain such an accuracy as to get the lamp within a half inch of a given position. By way of comparison, what would be thought of the carpenter who would declare that he could not make the door fit the jam within a half inch? One case is as remarkable as the other. Wherever prismatic glass is to be used, the exact position of the light-source should be ascertained and carefully specified; what is even more important, the fixture must be carefully inspected before being put in place, to see that the specifications have been followed.

Fixtures must also be designed so as to give convenient access to the lamps or burners, and to permit easy cleaning of the glass parts. This direction may seem so self-evident as to be unnecessary, but such is by no means the case. In fixtures where inclosing globes covering a number of lamps are used the construction is often such as to furnish a veritable puzzle to the caretaker; with the consequence that cleaning and renewing the lamps is delayed as long as possible, resulting in cutting down the illumination from thirty to fifty per cent. for the greater portion of the time. It not infrequently happens that electric lamps are so placed as to make it exceedingly difficult to connect them; and in many a fixture of elaborate exterior design, there will be found tangles of insulated wire within, often charred to brittleness by the confined heat, thus rendering the device exceedingly hazardous as a fire risk. Some of the mechanical atrocities of this kind perpetrated by even the better class of manufacturers are almost beyond belief. The fixture manufacturer generally stands as badly in need of a mechanic as he does of a decorative artist.

Daylight Illumination

By O. H. Basquin.

IX. Diffuse Reflection

Nature of Diffuse Reflection.—When light falls upon a material surface such as that of a block of glass or that of a silver coin, it may be considered as thereafter divided into three portions.

With clear glass it is evident that a large part of the light passes through the surface and enters the glass and in this glass it will travel a considerable distance before it is absorbed. In silver also a portion enters through the surface but it is able to travel only a microscopic distance before it is extinguished, probably being turned into heat. So it is with all substances, they allow a portion of the light incident upon them to pass in and be transmitted or absorbed in varying degrees.

If the silver coin is clean and bright and if the glass surface is fairly well polished, one finds from each a considerable portion of light to be regularly reflected. This reflection is imperfect in the coin because its reflecting faces are not all in the same plane. The same is true of the polish of a well blackened shoe, but the regular reflection is evident in each of these examples. Other examples in which this property is present but less well marked are writing paper, book covers, wood floor, dry paint and some kinds of cloth. As a general rule then we may say that all substances throw off in regular reflection a portion of the light incident upon their surfaces.

Finally, if the glass surface is ground with emery and if the silver coin is heated to redness and then cooled, one finds that the phenomenon of regular reflection has almost entirely disappeared from each of them. One finds each surface now of a white appearance which maintains the same brightness no matter from what direction it is viewed. This appearance of uniform brightness in all directions shows that a large portion of the light incident upon the surface is now scattered instead of being regularly reflected. This effect is spoken of as *diffusion* or *diffuse reflection.*

It is probable that there is little difference between regular reflection and diffuse reflection except that while the first comes from one flat surface or a series of flat surfaces nearly in the same plane, diffuse reflection comes from a multitude of surfaces set in various positions. One may picture the ground glass surface to resemble that of a piece of coarse sand-paper, while the microscope reveals upon the diffusing silver surface a network of tiny irregularities. The ordinary blacking as applied to the shoe, looks coarse and rough and is a fairly good diffusing surface, but after it is well rubbed down its roughness disappears, it is no longer a good diffuser, it has become a good reflector. As examples of good diffusing surfaces may be mentioned blotting paper, calcimine, wilton rug, and dirt road.

Perhaps the best illustration of the general type of surface is that of a piece of glass which has been poorly ground. It transmits light, the flat portions scattered irregularly about give a considerable reflection of the regular type, while the well ground portions give the phenomenon of diffusion. The regular reflection given by most surfaces may be looked upon as due to the circumstance that too large a proportion of the small reflecting faces are set nearly parallel to the general plane of the surface.

Diffusion Constant. The character-

istic of a surface with regard to the diffusion of any particular kind of light is specified by giving its diffusion constant, *k*, or, as it is frequently called, its coefficient of diffuse reflection. The diffusion constant is the ratio of the light thrown off in diffuse reflection to the total light received.

The total luminous current or flux received per unit area is defined as illumination and is measured in foot-candles. The current given out by unit area of a surface might be measured in spherical candles on the English system. For the purpose of this discussion it seems advisable to adopt a unit of flux which corresponds exactly to the *lumen* of the metric system, *i. e.* the flux per unit solid angle about a point source of unit intensity. By adopting this definition illumination in foot-candles is numerically equal to the flux per unit area, whereas it is numerically 4π times the spherical candles per unit area.

Considering now a surface whose area is *A*, whose diffusion constant is *k*, and whose illumination is *I*, the luminous current received is *AI*. The luminous current given out in diffuse reflection we may take to be *AH* small units. By our definition of the diffusion constant, therefore, we have.

$$k = H/I$$

Brightness Due to Diffusion. Problem: An area is given whose diffusion constant is known and whose illumination is assumed, it is desired to find the brightness which the surface will have due to diffuse reflection. This problem may be solved directly by the calculus methods, but it may also be turned into another problem the solution of which has been worked out at length, and this will now be done.

Fig. 1 shows two small surfaces of

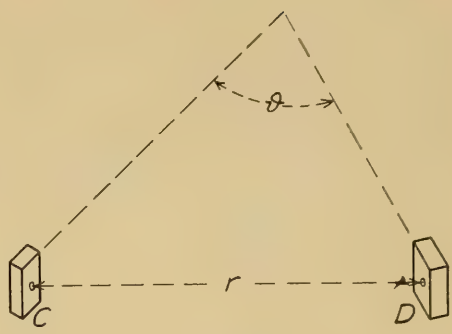


FIG. 1.

area *C* and *D*, whose planes make an angle δI with each other and whose centers are at a distance *r* apart. Let us suppose that the area *D* is of brightness *B*. The illumination at *C* due to *D* is known* to be

$$\frac{BD \cos \delta}{r^2}$$

and the flux received by the area *C* will be

$$\frac{BCD \cos \delta}{r^2}$$

Now, if we had assumed area *C* to be of brightness *B* and if we had found the flux at *D* due to *C's* light we should have gotten the same result as the above. This shows that for any two surfaces of the same brightness, the first gives the second the same flux which it receives from the second and vice versa.

Fig. 2 shows the surface of area *C*, illumination *I*, and diffusion constant *k*, whose brightness *B* is wanted. Imagine the surface *C* covered by a

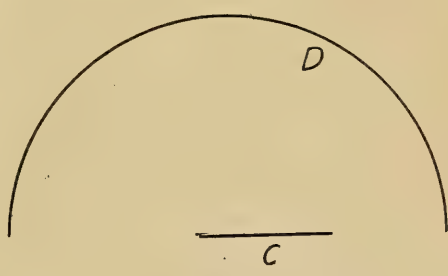


FIG. 2.

* See ILLUMINATING ENGINEER, Vol. I, page 1020.

hemisphere of internal brightness B, then the flux falling upon C due to the hemisphere will be πBC. But from the above proposition we know that this is the flux which actually comes from the surface C when it has brightness B. Hence by our definition of diffusion constant

$$K = \frac{\pi BC}{CI}$$

and we have from this,

$$B = \frac{KI}{\pi}$$

This equation defines the brightness of a surface under the effect of diffuse reflection. It is fundamental to a thorough understanding of the whole subject of diffusion.

As an illustration let us consider a surface lying horizontal and illuminated by an entirely unobstructed sky of brightness B_1. The illumination of this surface will be πB_1 foot candles, and the brightness will be kB_1 by the above equation. If the surface stands in a vertical position instead of lying horizontal, its illumination then from an open sky is only $\frac{1}{2} \pi B_1$, so that the brightness of the surface will be only $\frac{1}{2}kB_1$.

Measurement of Diffusion Constant. The first illustration in the above paragraph suggests a possible method of measuring the diffusion constant of any surface for daylight. If one can find a day in which the sky is of uniform brightness in all parts, he has then but to compare the brightness of the horizontal surface under an open horizon to that of the sky itself. The ratio of these two brightnesses is equal to the diffusion constant. While this is hardly practicable for accurate work it contains a good suggestion for off-hand estimates of such constants.

A diffusion constant is a property not only of the surface in question but also of the kind of light used in its measurement. This fact has had insufficient appreciation hitherto. It is evident, however, that a blue surface will have a small diffusion constant under a red illumination, whereas it may have a large constant when illuminated by light of shorter wavelength. Diffusion constants have been generally measured under illumination from incandescent lamps. Since this light is red we may expect such constants to be high for red surfaces and low for blue ones when compared with proper constants for use under daylight illumination.

For pure white surfaces and for pure gray surfaces this objection probably does not hold. It is very hard to measure the absolute value of a diffusion constant under daylight illumination, so it is especially convenient to assume that white blotting paper has the same constant under daylight and under artificial illumination. Sumpner's method of finding the diffusion constant is given in the *Philosophical Magazine,* February, 1893, and is illustrated in a modified form in Fig. 3.

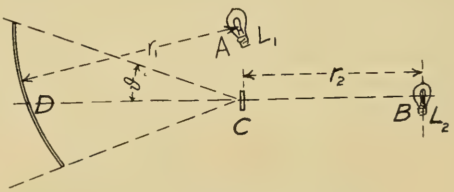


FIG. 3.

Using a Lummer-Brodhun photometer, whose screen is shown in the figure at C, the axis of the photometer bench is the line DB. A and B are lamps the ratio of whose candle powers, L_1/L_2, is known. The white paper is glued to the interior of a spherical surface, D, whose center is at A, making the illumination at D constant. In order to simplify the calculation of the illumination due to D on the

photometer screen, the paper screen is trimmed so as to just touch the conical surface of a cone whose apex is at *C*, axis *CD* and semi-angle δ, as shown in the figure.

The illumination of the screen, *D*, will be L_1/r_1^2. Its brightness, *B*, will be $B = kL_1/\pi r_1^2$. The illumination at *C* due to *D* will be $B \pi \sin^2 \delta$ or $kL_1 \sin^2 \delta / r_1^2$. But when the illuminations are balanced by means of the photometer, we have $L_2/r_2^2 = kL_1 \sin^2 \delta / r_1^2$. Solving this for k we have

$$K = \frac{L_2}{L_1} \left(\frac{r_1}{r_2}\right)^2 \frac{1}{\sin^2 \delta}$$

This modification of the method makes the computation simple and obviates any regular reflection which might enter from the face of the blotting paper.

Sumpner gives 82 per cent as the diffusion constant of white blotting paper. In the laboratory of the American Luxfer Prism Company, in 1897, a value of 83.7 per cent was found for this surface, but in that laboratory a whitewashed surface was used as a standard and its coefficient was found to be 87 per cent.

Having obtained one standard surface whose diffusion constant is known and assumed to be constant for illuminations of various color, one can easily compare, under daylight illumination, its brightness with that of any other surface and thereby obtain, indirectly, the diffusion constant of this other surface. This comparison is most easily made by the use of an illuminometer which may in succession measure the brightness of each surface under the same illumination. The Weber photometer may be used in this way, but one which uses the flicker principle is much more easily worked for surfaces of different color and such a device will be fully described in a section upon the measurement of illumination.

Estimation of Diffusion Constant. While the above provides for a fairly accurate determination of the diffusion of any sample of paper, board or other object which can be carried about, it will be convenient to have, in addition to the above, some method of estimating this constant applicable to streets, building fronts and the like which are permanently fixed in place and cannot be carried off to some laboratory and examined. For such use a set of gray papers arranged in the form of a fan has given excellent satisfaction.

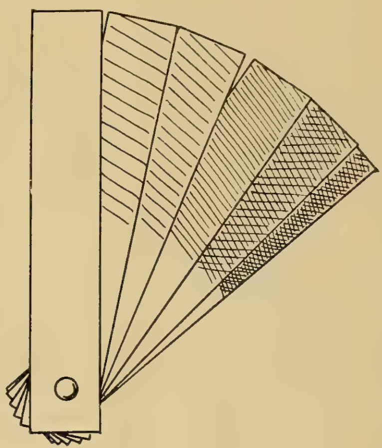


FIG. 4.

The form of the device is shown in Fig. 4. It is made of about 16 pieces of blotting paper, loosely fastened together at one end by means of a paper fastener. The strips of blotting paper are initially all white, but by diluting India ink one is able to give each card a different shade, making in this way a set of grays, whose diffusion constants vary from 5 per cent to 80 per cent roughly by steps of 5 per cent. Naturally a large number of cards must be shaded in order to get a set which will be satisfactory in the variation of their constants. The constant for each strip is, of course, determined in the regular way and may be marked on its back.

In using this device to determine approximately the diffusion constant of a sidewalk or a building front one unfolds the papers so that the three or four show which have something like the same appearance as the surface in question. One then lays the device down on the surface in order to get the same illumination on the papers as on the surface. He now studies them carefully and picks out the paper which corresponds most nearly with the surface in question, or he finds that the surface lies in brightness between a certain two of the papers. In either case the constant for the surface is easily approximated.

Gray papers have the advantage that since the colors are simply combinations of black and white, their diffusion constants will be the same on all days no matter what the color of the sky. Gray harmonizes also with most colors so that it is easier to compare the brightness of any color with a gray than with any other different color. The comparison is sometimes more easily made by looking at them at some distance from the eye. In this way the values for the following table have been estimated.

Coefficients of Diffuse Reflection Estimated in Chicago.

Very dirty granite, dry	10%
" " " wet	5%
Dirty granite, dry	25%
Clean white tile	65%
Soiled " "	55%
Average building front,	5, 10, 15 and 20%
Stone sidewalk, dry	30 and 35%
Another stone sidewalk, wet	15%
Cobblestone street, dry	20%
" " wet	5%

Estimated in Evanston, Ills.

Red brick wall, dry	15%
Board walk, dry	15%
Old wall of light-colored brick, dry	30%
Cement walk, dry and clean	35%
Old wall of hard limestone, dry	45%

Window Areas. In estimating the illumination to be obtained by diffusion from a given building front, one must naturally take into account the proportion of that wall which is taken up for windows. The interiors of buildings are so dark that the diffused light to be obtained from window openings is almost nil and should be neglected, *i. e.* in making up an average diffusion constant for the building front the window spaces are counted as so much black wall. In the office buildings of Chicago the window area is about 40 per cent of the front. In New York the window area seems to be much lower, the average probably not being much over 25 per cent.

Illumination Due to Diffusion. We have seen that each point on the face of a building is directly illuminated by the sky. From each of these points then must proceed a light current and the brightness of the surface at any point due to direct illumination may be found from the principles given above.

Let us consider a window in a building front. Its direct illumination we already know, but it is also illuminated by each point of the opposite building-front and of the intervening street surface. This illumination due to the first diffusion must now be estimated. Divide the opposite building-front up into a series of strips of convenient size and find the direct illumination at the center of each strip. Consider each strip now as having an illumination over its whole area equal to that at its center, find its brightness and then its component toward the illumination of the window in question. The street surface is treated in a similar way and all the effects added together as the whole illumination of

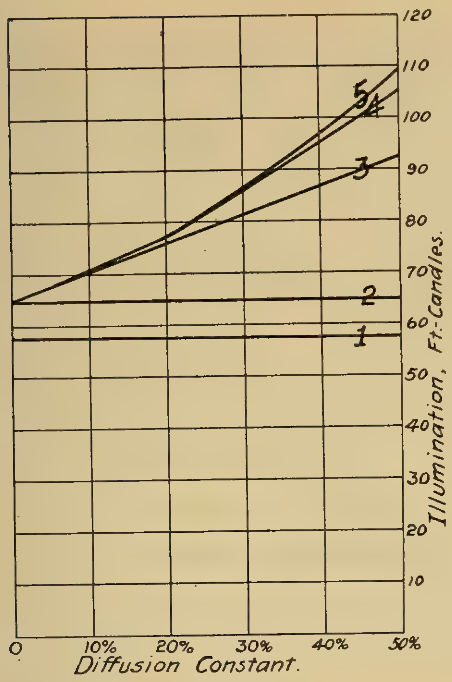


FIG. 5.

the windows due to first diffusion.

The calculation of the first diffusion is not difficult or tedious. There is, however, no end to the number of diffusions which one can imagine, but there is a limit to the number of diffusions which are of any importance. To estimate the second diffusion one must first find the increase in brightness due to the first diffusion at the center of each strip. Then he finds the increase in illumination at the window for each of these increments of brightness, considered as extending over its appropriate strip. The calculation of the third diffusion is similar in method but becomes very tedious and is generally of small importance.

The curves shown in Fig. 5 refer to diffusion in a street 80 feet in width and with buildings 140 feet high on each side, the average condition in the newer parts of Chicago. The sky is assumed to have a brightness of 250 candles per square foot and the street surface is assumed to have a diffusion constant of ·8 per cent. The abscissas are the diffusion constants of the building fronts (assumed as varying) while ordinates refer to the illumination of a point in the building front 10 feet from the sidewalk—taken to represent an average value for the ground floor.

Below the line "1" is illumination due directly to the sky. Between lines "1" and "2" is illumination due to the first diffusion from the street surface. Between lines "2" and "3" is that due the first diffusion from the opposite building. The effect of the second diffusion is shown in the distance between the curves "3" and "4." The small effect of the third diffusion is shown between the upper two curves.

These curves show that white tile building-fronts would cause an increase in the illumination of the ground floor fronts nearly equal to the direct illumination from the sky. A number of such white tile buildings have been erected in Chicago. Public appreciation of such advantages to the city should be encouraged. When the city has become covered with tall buildings both dark and dirty, the need of tile fronts, light in color and easily cleaned, will be evident to all. Now is the time in which public sentiment can do the most good.

Studies of Notable Instalations

The Hoboken Terminal of the Lackawanna Railroad

A modern railroad terminal probably contains a greater variety of public utilities, and affords a more complex problem of illuminating engineering, than any other single building. The Hoboken Terminal of the Lackawanna Railroad, now nearing completion, has the unusual feature of a water front, thus furnishing a boat as well as a railroad terminus. The illumination, therefore, involves both interior and exterior lighting, the latter including beacons for marine use, and purely display lighting, as well as general illumination of ferry slips and street approaches. Although the installation is not yet completed, the plans are matured, and the interior installation is sufficiently advanced to permit a very just estimate of the scheme as a whole.

As will be seen by the illustration, Figure 1, which shows the water front of the building, the general architectural effect has been as carefully studied as the numerous practical conveniences. While there has been no straining for slavish adherence to some particular architectural type, the best features of classical Greek design have been utilized. In its general lines and proportions, as well as in the interior decorative features, the archi-

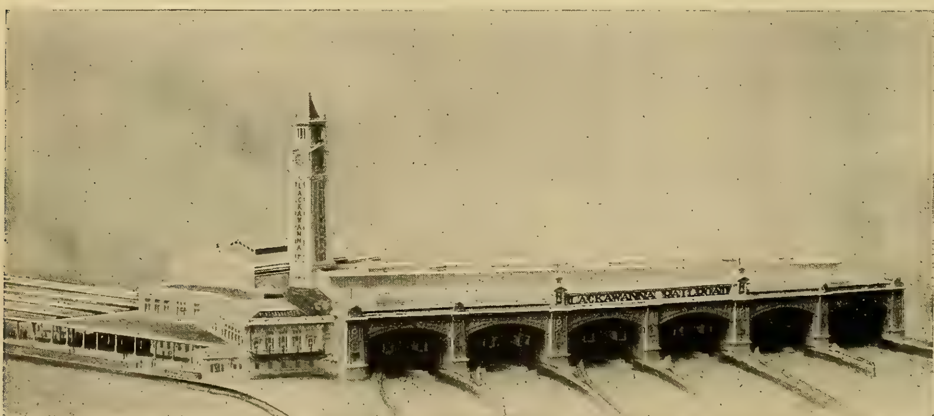


FIG. I.

FIG. 2.

tect, Mr. Kenneth M. Murchison, has been particularly successful, if a layman may be permitted an opinion. At the expense of digressing somewhat from strict adherence to the subject proper, we cannot help noting the vast improvement of the train sheds, which are of the umbrella type as shown in Figure 2, over the old style of single arched roof. There is practically no reverberation of sound, which was such an annoyance in the old style shed, practically no accumulation of smoke, and far better light, both by day and night. We understand that the new thirteen million dollar Union Station in Washington is to have the same kind of sheds. While on the subject, we may as well describe the artificial illumination. As will be seen, the train sheds are lighted by frosted lamps placed against the arches of the supporting columns, lengthwise on the platforms, there being five lamps in each arch. The illumination on the platforms is .2 foot-candles, which is hardly sufficient for the purpose. The intensity could probably be doubled by the use of clear lamps and the proper reflectors, and would then be the same as the illumination of the concourse, which is satisfactory.

The railway concourse is shown in Figure 3. The illumination here is by clear sixteen candle-power frosted lamps studded along the girders which support the skylights. The illumination on the pavement is .4 foot-candles. A considerable increase in this efficiency might be obtained by the use of reflectors, and if bowl-shaped prismatic reflectors were used they would

FIG. 3.

FIG. 4.

FIG. 5.

prevent the bare lamps dazzling the eyes. From this concourse a broad inclined passage leads to the concourse connected with the upper decks of the ferries. This is shown in Figure 4. The illumination is by chandeliers of a simple design in wrought iron, each supporting twelve 12-inch opalescent globes in the circle, with a larger globe in the center. The small globes contain one lamp each and the center globe three lamps. The walls and ceiling are finished in white plaster.

The ferry concourse, the southern end of which is shown in Figure 5, is 450 feet long, 70 feet wide, and divided into 50-foot bays, each of which is lighted by 36 frosted 16-c.p. lamps placed in the panels formed between the double supporting girders. The ceiling and walls here are finished in white plaster, the floor is teselated marble of a pink cast. The illumination on the floor varies from .5 foot-candles in the center of the bay to 1.2 foot-candles directly underneath the lamps midway between the pillars Side brackets are also used on the pilasters, each bracket supporting an opalescent globe containing 3 lamps. The height of the ceiling is 28 feet.

The restaurant is a particularly handsome room, as shown in Figure 6.

The walls are finished in "old ivory," the ceiling in white, relieved with a moderate use of gilding. The floor is teselated, of a light neutral green tint. The woodwork is dark mahogany finish. The lighting installation consists of two chandeliers, each containing 24 2-inch round frosted lamps placed upright on the tips of imitation candles; twenty side brackets on the pilasters, each with four imitation candles with frosted lamps; four clusters, on the corners of the

FIG. 6.

central panel of the ceiling, each cluster containing six lamps; and twelve round frosted lamps studded around the panel as shown. The illumination on the tables is 1.7 foot-candles.

The waiting room is on the track level, and is 90 x 100 feet, with a ceiling height of 00 feet. The walls are finished in white plaster. The floor is teselated, of a light tint; the woodwork, antique oak. The glass skylight is 49 x 80 feet, and on three sides of the room there are large windows glazed with rough glass of amber color. The artificial illumination of this room exhibits practically all the methods of interior lighting in common use. Direct lighting is provided by four chandeliers suspended from the four corners of the ceiling, together with wall brackets on the sides of the room which do not show in the illustration. Besides these fixtures, there are 40 frosted lamps placed in the rosettes in the small panels into which the larger panels about the sky light are divided. Indirect lighting is furnished by 251 lamps placed back of the cornice which supports the ceiling cove. There are also incandescent lamps placed above the skylight. A feature especially worthy the attention of illuminating engineers, is the special light provided for reading by those occupying the settees. The arrangement consists of an inverted trough placed upon the back of the seats, consisting of an artistic bronze frame work glazed with a slightly opalescent art glass. Clear, four candle-power lamps are placed underneath, 9 inches apart. Sixteen candle-power lamps were originally installed, but were thought to be un-

FIG. 7.

necessary. The lamps are so placed as to be just hidden from the view of those sitting on the opposite seat. The illumination produced is simply perfection for the purpose intended. No matter how closely the seats may be occupied, it is impossible for one to throw a shadow upon the paper or book of his next neighbor. A railway station waiting room is not primarily a reading room, but we cannot recall an instance of a reading room in any public library which can compare in its lighting with this room, and we earnestly commend this example to the careful study of librarians or architects having charge of libraries and reading rooms.

Taken as a whole, the interior lighting has been admirably worked out, and while not the work of a professional illuminating engineer, it affords an example which will well repay the careful study of the profession. There are a few points, however, which are open to criticism, but in every case this criticism is rather from the artistic than from the engineering standpoint. The chandeliers in the restaurant seem to us incongruous in themselves, and out of harmony with their surroundings. Although the structural features of the room are classical, which is essentially plain and substantial, there is, in the surface finishings and in various touches of decoration, a certain delicacy of effect with which the clumsiness of the chandeliers produces an unpleasant contrast. To analyze their construction, the arms nominally represent torches, each bearing five candles. Picture to yourself an actual torch with five candles stuck in the end, and the handle

given a bend so that six of them can be stuck into a single block of wood, and the collection hung up by a chain; if the combination does not suggest to you an illustration in one of Mark Twain's books, in which he shows a native Fiji Islander with starched cuffs around his ankles, a dress coat with the sleeves tied around his waist, and a silk hat on his head, we leave it to your own imagination to make a more fitting comparison. If chandeliers were considered essential, some of the magnificent designs of modern crystal construction would have been particularly effective. Frosted incandescent lamps placed in the dental course of the elliptical panel would have also given a beautiful, difused light. Table lamps, with small candle shades would have added greatly to the general cheerfulness and decorative effect of the room. As the tables are placed in position once for all, such lamps could have been very easily provided.

The waiting room, with one exception, is one of the most attractive rooms we have ever seen, being marred only by the presence of the four chandeliers which are entirely unnecessary from the illuminating standpoint, and consequently obtrude themselves as an impertinance upon the vision. Individually considered their weight is so grossly out of proportion that one unconsciously avoids walking under them for fear that their proportionately slender support may unexpectedly give way. If these were removed, and a hemisphere or sphere of frosted or prismatic glass of proper size were placed in the panels, the general effect of the room would be enhanced. In contrast to these anomalous creations, the fixtures used in the passageway between the concourses are a most welcomed relief; there is a simple circle of metal, with its severe outline relieved, by just enough ornamentation to differentiate it from a purely mechanical support, and this is sustained in the simplest, and consequently the most effective manner, by a number of properly proportioned chains running to a central support on the ceiling. The dead black finish adds to the effect of the subserviency of the metal parts to the luminous globes which they support.

The exterior lighting will include some strikingly novel features, as well as good examples of signs and outline work. The large sign, "Lackawanna Railroad," on the water front of the building is made up of letters 9 feet high. The arches of the ferry slips will be outlined with incandescent lamps. The most striking feature of the exterior lighting, and one which will make this tower the most conspicuous object at night on the entire North River water front, will be a cluster of 49 flaming arc lamps which will be arranged in series within a single globe 6 feet in diameter, each arc consuming 16 amperes at 2,300 volts. It is estimated that a candle-power of 1,500,000 will be reached. This will unquestionably be the most powerful light ever produced from a single fixture. The globe will be suspended from the upper part of the tower. Besides being the most impressive spectacle, this experiment will prove of no little commercial value in demonstrating the possibility of lighting large open spaces with exceedingly high candlepower units placed at a proportionately great distance above the illumined surface.

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The First Annual Convention of the Illuminating Engineering Society

The Illuminating Engineering Society held its first annual convention in Boston on July 30th and 31st. It was an unqualified success. In point of attendance and in the character of the papers presented; in the close attention and animated discussion which was given to the papers; in the general good fellowship and social enjoyment of the occasion, the event surpassed the most sanguine expectations of the members, and was a convincing proof, if such were needed, of the hold which illuminating engineering has taken upon the general public. To attain a membership of more than 1,000, and to have present over two hundred, more than half of whom were members, at its first annual convention, is a record which has never before been equalled in the growth of scientific societies. The time and place of meeting undoubtedly had much to do with its success; and Mr. John Campbell, Chairman of the New England section, and Chairman of the Convention Committee, should be congratulated for urging the many advantages of "Old Home Week" in Historic Boston, upon the Council of the Society.

The convention was called to order at the appointed time by Chairman Campbell, and was welcomed in an address by Hon. John F. FitzGerald, Mayor of Boston. This was followed by the President's address, entitled: "The Concepts and Terminology of Illuminating Engineering."

The address will be found printed elsewhere in this issue.

Dr. Sharp's paper is an admirable example of the exposition of a comparatively abstruse subject in a logical, clear-cut, and comprehensible manner, and is worthy of study by technical writers as a piece of scientific literature, apart from the particular information which it contains. American technical schools have often been criticized, and justly so, for the inability of their graduates to express themselves in clear, strong English; and it must be admitted that scientific treatises, as a rule, are expressed in better literary form by foreign writers than by American. It is consoling to

know that we have some exceptions to this rule, and Dr. Sharp must be regarded as among these.

Dr. Sharp makes an appeal for a more scientific and logical terminology for the various quantities used in illuminating engineering. Of the terms which he recommends, which, if we are not mistaken, were first proposed by Prof. Blondel, there can be no question, so far as their scientific deduction is concerned; but unfortunately, like the metric system their general adoption necessitates a reversal of custom to some extent, and as everyone knows, to change a custom is one of the hardest tasks to accomplish in the whole range of human affairs.

Hope is expressed that the report of the Committee on Nomenclature and Standards which was appointed by the Illuminating Engineering Society some months ago, will be of material assistance in bringing about the desired change; but in view of the numerous recommendations and legal enactments in regard to the metric system, we are not very sanguine in this respect. Probably the only thing that will ever bring about a more rational system of photometric measurements and terms is the establishment of a regular course of illuminating engineering in the technical schools. The adoption of the metric system for scientific work is due almost entirely to its use in schools and colleges. When we have illuminating engineers who can claim their professional title as the results of systematic technical education, the question of uniformity in terminology will be solved.

Dr. Sharp's treatment of the subject of efficiency especially deserves the most careful study by those seeking information on illuminating engineering subjects.

Primary, Secondary and Working Standards of Light

Under the title given above Dr. E. P. Hyde, of the National Bureau of Standards, gave an admirable explanation of the distinction between the three standards, the theoretical requirements for each, and outlined the difficulties of reaching these theoretical requirements. The idea of a primary standard for the measurement of any quality is a peculiarly fascinating one to the scientist. As Dr. Hyde points out, the one qualification for a primary standard is reproducibility; and some of the most brilliant scientists have been chasing this phantom more or less for the past century. As a matter of fact there is no such thing as an absolute, primary standard, according to this definition, in existence, excepting the unit of time. The standard of length is, in fact, though not in theory, the distance between two scratches on a metal bar; and if these particular metal bars were destroyed some one of the numerous copies would be taken as the "primary" standard, rather than a certain portion of the circumference of the earth, or the length of a pendulum beating seconds, as we were taught in primary school. Similarly, the unit of mass is, in reality, that precious block of platinum kept by the French government; and since length, mass, and time are the only primary quantities to be measured, it follows that there are no actual reproducible primary standards.

If it is impossible, as is the case, to secure a primary standard of such elementary quantities as mass and length, what may be expected of such a complex phenomenon as light? The incandescent electric lamp has unquestionably done more to bring photometry to such a degree of working accuracy as to give it practical value than all the researches for primary

standards put together. In view of this fact, and especially in view of the numerous new materials that have been developed for the incandescent filament, would it not tend to greater practical results if the time were spent in studying the characteristics of this "secondary standard," with the view of obtaining an arbitrary standard which would be practically invariable, and from which copies could be made with a degree of accuracy limited only by the accuracy of photometric measurement? It seems likely, at any rate, that this will be the actual outcome of the whole matter of photometric standards.

Another matter to which Dr. Hyde calls atention, and which might readily be overlooked by the illuminating engineer, is the desirability of using a flame standard for measuring flame light-sources, in order that the variations of light due to variations in atmospheric conditions may be self correcting.

Illumination Photometers and Their Use

This subject was discussed in a paper presented by Mr. Preston S. Millar, in which he described the various portable photometers and illuminometers that are at present obtainable. An abstract of the paper is printed in another section of this issue. This paper aroused perhaps as much general discussion as any of the papers presented, due to the fact that the subject in itself is both comparatively new and of great importance, and also to the further fact that within the past year or two a number of new instruments have been brought forth by various investigators, any criticism of which was as sure to produce a defence as would the criticism of an only child arouse the ire of its parents.

Without wishing to take up any of these family quarrels, we must beg leave to differ with Mr. Millar on the question of terminology. We object to the term "Illumination Photometer." It is both cumbersome and unnecessary. There is a very plain distinction between a photometer, which is an instrument made especially for measuring the intensity of light in one particular direction, and an illuminometer, which is especially designed to measure the illumination produced upon a dead white surface from light falling in every possible direction. Since the two instruments deal with measurements of light they require a working standard light-source and some form of "screen"; but the mechanism by which these elements are utilized for the specific purpose in each case is quite different, different enough to place the two instruments in two distinct classes. The word "Illuminometer" is formed in strict accordance with English etomology, bears its definition upon its very face, and is a single word.

We protest still stronger against Mr. Millar's attempt to attach the word illuminometer to what he calls "visual acuity photometers," *i. e.*, instruments in which the intensity of illumination is judged by the ability of the observer to distinguish certain letters or characters. Such an instrument is primarily neither an illuminometer nor photometer, but simply an eye tester. The terminology of illuminating engineering is in bad shape as it is, and it is to be devoutly hoped that no more opportunities for misconception and deception will be given by the addition of further ambiguous terms.

There is no more important matter in the whole subject of illuminating engineering at the present time than this question of illuminometry. To accurately measure the illumination

produced is to put the seal of scientific proof upon the entire work of the illuminating engineer, and until this can be done to a degree of accuracy at least comparable to the photometry of light-sources, illuminating engineering must remain more an art than a science.

Acetylene Lighting

Acetylene as an illuminant has thus far received but scanty attention from illuminating engineers,—at least, to judge by the proceedings of their Society. This in reality is not a reflection upon this means of illumination, but a simple result of existing conditions. The field of illuminating engineering is, so to speak, a virgin forest, and the first task is to blaze a trail, which the immediate successors of the pioneers may follow; and this trail must naturally lead to the most prominent land marks, which are electricity and gas.

Acetylene is in the unfortunate position of the dog with the bad name, and if illuminating engineers can do nothing further than to correct the popular misconception of this valuable illuminant, they should at least lend their energies to this task. On account of a few disastrous explosions, which resulted from ignorance of its properties and the simple precautions necessary in its use, at the very outset, the bad name thus obtained has followed it all the days of its life; and to those who have never actually used it, the word acetylene at the present time is only another expression for explosion.

It is unnecessary here to go into a discussion of the relative safety of acetylene lighting. That it is at least as safe as ordinary illuminating gas as commonly distributed, has been proven time and again, both in theory and practice; and to disabuse the public of its prejudice in this respect is a duty which all those concerned with the progress of lighting should lend a hand.

The beautiful quality of the light of the acetylene flame should also appeal to illuminating engineers.

The manufacture of carbide at present is an absolute monopoly of the one kind which the government not only permits but creates, otherwise known as patent protection. Such monopolies are comparatively short lived; and when these particular patents have expired, which will be in the near future, the price of carbide will naturally be greatly reduced by open competition, and acetylene lighting take a consequent long leap forward. There is said to be 150,000 residences using it at the present time and some 350 cities and towns using it for public lighting.

It is worth observing that carbide is a product of the electric furnace and hence acetylene lighting may be considered an indirect form of electric lighting.

Trade Bulletins and "House Organs"

The rapid increase of this class of literature of late naturally suggests the question as to its advantages compared with those of regular advertising and contributed articles in the trade and technical press. If the question were put categorically to the concerns issuing their own literature, they would probably evasively reply, "both"; and to comment in the same delphic manner, we may say that they are probably right. All kinds of publicity are good in their way; and that the two ways just mentioned at least digress sufficiently to make separate vehicles necessary for their travel, seems to be proven by the facts. Each can sustain its position by valid arguments. Thus, the private bulletin or house organ is free to say exactly

what it pleases, to dress itself up as taste and expense may dictate, and to call at whatever address the house may choose, and as often as conditions may be deemed to warrant. Instead of being published at stated intervals, it can, like the little magazine of a well known latter day philosopher, be published "every little while."

On the other hand, no matter how true, how scientific, or how well expressed the statements may be which it contains, and no matter with what exquisite taste of design and workmanship it may be gotten up, the fact that it is a private publication cannot be disguised; and this fact, which is bound to protrude like the traditional cloven hoof of a certain well-known and active personage, will always cause its statements to be taken "with a grain of salt." Even when none exists, the ulterior motive will be assumed. Self praise never did go far, but perhaps it is better than no praise at all.

Much of the matter contained in these private publications is of the nature that has heretofore appeared in the "write-up" department of the trade and technical press, and to the extent that it relieves the regular publication in this regard the reading public is to be congratulated. In other cases the matter contained is of intrinsic merit, either as commercial news or scientific fact, and therefore its legitimate place is in a special trade or technical journal devoted to the subject.

Mark Twain tells of a certain man whose veracity was somewhat elastic, and he consequently cautioned a friend who had repeated some of these questionable statements by saying, "You can only believe half he says": to which the friend immediately inquired, "but which half"? We do not mean to infer that the statements made in private literature contain any positive misstatements, but it is to be expected that they will always "put the best foot forward," and will not consider themselves bound in all cases to speak the whole truth; and no matter how plausible and true the arguments presented may be, there will always arise in the reader's mind the question, "what has been left unsaid?" and the doubt created by the omission may be actually far worse than the opinion which would result from a full exposition of the case such as would be given in an independent publication.

It is probable that, if accurate statistics were obtainable, it would be found that numbers of sinners have been converted by receiving religious tracts through the mails; but the ratio of converts to tracts is undeniably a small one. As a means of general education the private publication undoubtedly has its use, but the number of customers secured in proportion to the number of pamphlets can not be very large.

The final resting place of all advertising matter is the waste basket, and its message, therefore, is only made during its flight from the press to its predestined repository. It is a bird of passage which can impress its habitat and characteristics upon the average observer only by continuous and frequent flight. The independent periodical, on the other hand, is invested with a greater or less degree of permanency, and in many cases assumes the character of a friend, whose regular calls are awaited with a greater or less degree of interest and pleasure, and who is questioned as to the news and messages which he brings.

Correspondence

From Our London Correspondent

New Gas Fixtures.

Great advances are being made in the manufacture of gas fittings, due in no small measure to the use of flexible metal tubes; these tubes lend themselves particularly to pendant lamps. At the recent Ironmongers' Exhibition, held in London, a great variety of these pendants were shown. Figure 1 is typical of the first form of rise-and-fall pendants. The head is turned out of solid metal, and the weights are two castings with a hole through the center, and a brass chain which renders it impossible to accidentally detach the weight from the fitting. The tension can be increased at will, and so regulated that the pendant remains stationary at whatever position it may be drawn down to. Figure 1 shows the form and mechanism.

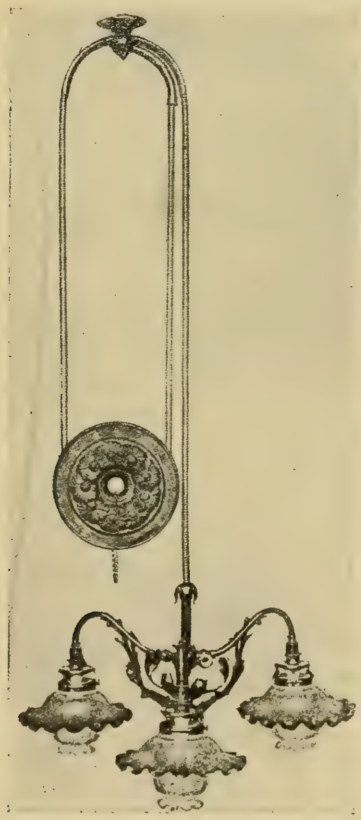


FIG. 1.

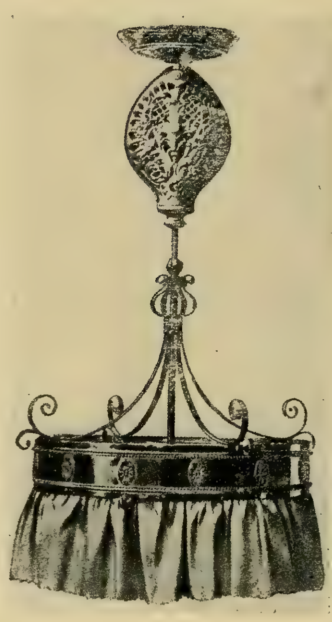


FIG. 2.

Another pendant has now been in-

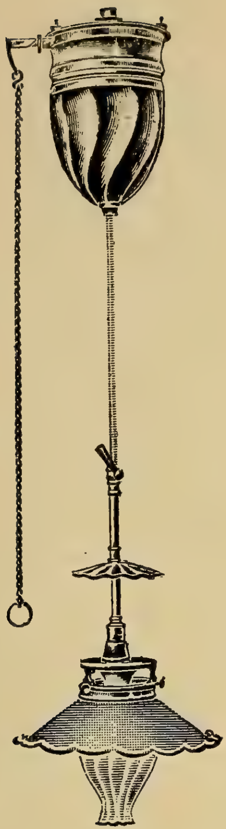


FIG. 3.

troduced (Fig. 2); in this form no counterbalance is used, a spring being employed to coil up the flexible tube when the pendant is raised, the balance being obtained by means of a screw attached to a friction plate. One or more burners may be used on the pendant; it will carry any weight desired, and the friction plate regulates the rise and fall of the burner; it is protected by means of a leather washer. The fitting containing the coiled flexible tube is made in a variety of material, and is not at all unsightly, being attached, as shown, to the ceiling plate.

At the same exhibition, the Harquin pendant was shown (Fig. 3). In this fitting the flexible tube is coiled on a fixed drum, the axis of which is vertical, the tube being thrown on the drum by a specially arranged pulley. The fitting can easily be adjusted to take the weight of any form of fitting; an automatic check is fixed in order to prevent the accidental fall, should there be any interference with the working of the drum. The pendants are sent out with a patent cut-off needle valve; the outward pull of the chain opens it, and a downward pull cuts off the gas.

The Bloch Light, Limited, originally an American firm, are making great headway with their burners and mantles. They have factories at Putney and Streatham, both London suburbs. The first mentioned has a producing capacity of 7,500,000 per annum, with a total of 25,000,000. The works are both replete with specially designed and up-to-date machinery. The work of making mantles is carried on mostly by girl workers, who tend the special machines, handle the crude mantles, and turn out 5,000 per day, finished and ready for sale, the only attention required being given by two girls. Until recently the company were paying $7.80 per kilo. for thorium nitrate, but they have now entered into a contract at a reduction of $1.20 per kilo.

REGULATORS FOR INVERTED BURNERS.

Attention has, from time to time, been called to the paramount need of a regulator for inverted incandescent gas burners; manufacturers are quite alive to the necessity, and already several new regulators are being introduced. Among other inverted burners may be mentioned the "Veritas" (see Fig. 4). The regulator, it will be noticed, enables the nipple to be instantly adjusted to suit the pressure as the gas issues into the Bunsen tube. The burner has also an air-regulator and a special by-pass; these all make for

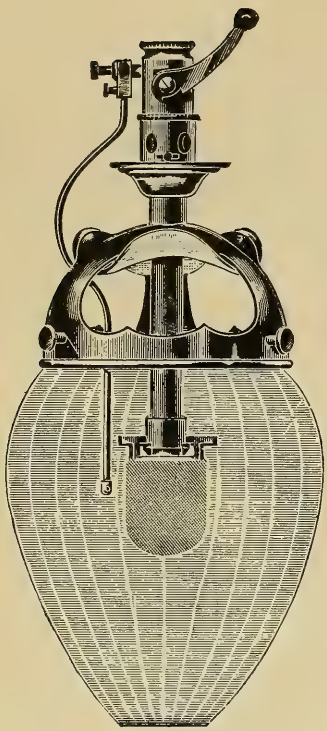


FIG. 4.

perfect combustion and small consumption of gas with high luminosity of flame.

MR. WEBBER'S RULES FOR GAS ILLUMINATION.

Addressing a large number of Ironmongers, Mr. W. H. Y. Webber, an expert in gas matters, dealing with good gas lighting, said there were seven simple rules which they should follow, viz:

1. Do not put an incandescent gas light in the line of sight, but always above it.

2. Never use an incandescent light without a reflector over it in order to throw the light in the direction where it is most required.

3. If an incandescent light is likely to meet the eye within a distance of 10 feet, it must have an opal shade independent of the reflector.

4. Allow for interior lighting by pendant lamps, one "C" No. 2 Kern, or a full-sized inverted lamp to every 150 square feet of floor area. For "Bijou" inverted lamps, use thriee the number of pendants, and four times if on brackets. This rule applies to lights at the usual domestic height of 6 feet 6 inches above the floor. At the usual shop height, of about 8 feet 6 inches, double the number of lights may be employed.

5. The most equal distribution of light is given by lamps spaced at one and a half times their height apart.

6. Use pilot light burners for shops, work-rooms, etc.

7. Outside shop window lamps should be as low and as far away from the glass as possible.

Of course, these rules can only be considered as suggestive. It is quite impossible to make any hard and fast rules for the illumination of domestic apartments and shops. It is now a fairly accepted fact that points of light should be increased rather than that an excess of luminosity should be concentrated at a few points. The present popularity of the inverted burner has done much to make this possible. The light and elegant designs of fittings used for the electric glow lamps have now, to a considerable extent, been adapted for gas, especially for the "Bijou" inverted incandescent burners. These lend themselves to decorative purposes, and when carefully fitted, give a much more constant illumination than the glow lamp; this fact is gradually being brought home to the British public. For a long time past the glow-electric lamp has been waning in popularity. Its use for intermittent lighting answers very well, but for continuous burning it is quite apparent that the filament becomes quickly charred. The cost of current to maintain the illuminating

FIG. 5.

generative principle has recently been patented; the illustration (Fig. 5) shows the lamp complete. In Fig. 6 we have a section of the body of the lamp; A is a perforated outer casing; E a finely perforated metal screen; C are air inlets to the heating chamber, and D E are passages for carrying off waste gases. The space shown between the outer casing A and the inner annular space next the heating chamber, keeps the outside of the lamp cool and prevents the discoloration of the lamp. This lamp is known as the

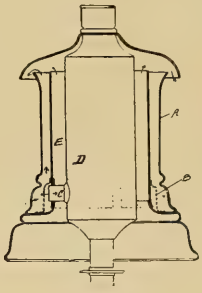


FIG. 6.

standard increases with the resistance of the charred filament, and ultimately it is so affected that the luminosity is reduced by at least one-half. In the case of the glow lamp, no cleaning is possible, whereas with the incandescent mantle, a good blow through will clean the "mesh" and the mantle is equal to new; as a matter of fact, the heat itself destroys the particles of dust that may be attracted to the mantle when out of use. To-day, so perfect is the combustion with these burners, that no carbon deposits appear either on mantles or fittings.

REGENERATIVE GAS LAMPS.

So great has been the interest taken in the simple form of incandescent gas lamps that regenerative gas lamps, which were so much in evidence some fifteen or twenty years ago, are now seldom seen. A lamp upon the re-

"Uno," and is manufactured by the Ecliptic Gas Light Company. It may be fitted with a single mantle, or with the company's bulbous burner head containing three or more mantles. The lamp will stand a considerable amount of draught and it is stated that the lighting efficiency per cubic foot of gas is high.

MAINTENANCE OF GAS LAMPS.

The question of maintenance of consumers' burners and mantles is receiving much attention at the hands of gas suppliers. The Corporation of Hereford are the owners of the gas undertaking; gas is sold at 54 and 60 cents per 1,000 cubic feet, according to the quantity consumed. The public lamps are all supplied with incandescent burners, and the use of them for domestic lighting is rapidly becoming

universal. A scheme has been adopted for maintaining incandescent lights by contract at 19 cents per burner for three to six lights; 16 cents for six to twelve lights; 14 cents for twelve to twenty lights; and 12 cents per burner per quarter for over twenty lights. The burners are periodically inspected and cleaned, new mantles being supplied when needed.

LAMPS REQUIRED TO PRODUCE A GIVEN ILLUMINATION.

Upon being asked how to calculate the number of lamps required to illuminate properly an apartment 24 feet square, a leading paper answers: "It is impossible to give a rule applicable to all cases. Thus, a drawing-room usually only requires a comparatively low illumination, while a dining-room requires much more. The position of the lamps will also vary the number required for a given space, and also the color of the walls. About half the number of lamps of any particular candle-power are required with a white paper to that needed when the paper is dull red or green. For a good general illumination, where the lamps can be distributed equally over the space, we should allow a 16 candle-power lamp for a radius of 5 feet. This would mean about six lamps of 16 candle-power for a room 24 feet square. If the lamps are all fixed in the center of the room it would require more lamps to illuminate the whole area; probably four 32 candle-power lamps in the center would be about right."

COPPER CELLULOSE MANTLES.

At a recent meeting of the Silesian Association of Gas and Water Engineers, Herr Bruno, of Berlin, sketched the development of the incandescent gas mantle. He described the early methods and said that after prolonged experiments, it was observed that a satisfactory mantle could be made from copper-cellulose by impregnating it, after being knitted into the proper shape, with a solution of thorium nitrate, and then decomposing the salt within the fabric by treating with ammonia so as to produce thorium hydroxide. This method had, he said, numerous advantages. In the first place, thorium salts are known to be hygroscopic; so that when mantles made from them are supplied—as is usually the case with large consumers—without being burnt off and collodionized, they have the defect of greedily taking up moisture from the air. If a mantle becomes damp, it loses its proper shape when it is placed on the burner and the gas is lighted. Mantles made of copper-cellulose impregnated with thorium hydroxide precipitated *is situ* are naturally free from hygroscopicity. He states that they can be soaked in water for hours without losing any of the rare earths. Thorium nitrate, the only thorium salt hitherto used in the preparation of mantles, has the property of swelling enormously when it is being converted into oxide by ignition. So much is this the case that a piece of the nitrate, about the size of a pea, heated in a 20 c.c. platinum crucible, expands sufficiently to overflow the vessel. This property is still used as a test for the quality of thorium nitrate, for it is believed that a salt which swells largely on ignition will not sinter-scale when present in a mantle.

In the next place, mantles of copper-cellulose impregnated with thorium hydroxide are much stranger than others. Tested in the Drehschmidt machine, an ordinary mantle will bear, at the best, only some 90 or 100 shocks, whereas a copper-cellulose mantle will not be injured in the least by 2,000 or even 3,000 shocks. Again, an ordinary uncollodionized mantle

will not bear touching, breaking off at the head; but, we are told that a copper-cellulose mantle impregnated with thorium hydroxide will resist a very considerable amount of force.

Herr Bruno says that instead of using ammonia as a precipitant, hydrogen peroxide may be employed; this re-agent throws down thoria but dissolves ceria. Hence it is necessary first of all to heat the hydrogen peroxide with such an excess of cerium compounds that, when it is used to precipitate the thoria, the finished mantle contains a proper proportion of ceria. When this last process is adopted, the mantle does not contain thorium oxide in the usual form—as ThO_2, but contains a higher oxide—Th_2O_7, and mantles so prepared will often exhibit an illuminating power from 130 to 140 Hefners, instead of the 120 to 130 Hefners, which is considered characteristic of mantles made in other ways when tested under identical conditions.

TESTING GAS METERS.

In a previous communication, we drew attention to the subject of gas meter testing and explained the limits provided by our sales of gas act. Wharton H. Humphreys, engineering the Salisbury Gas Works, has recently been conducting some interesting investigations into the question of unaccounted-for gas and consumers' meters. He describes his work at considerable length in an article published in the *Gas Journal.* After explaining the act upon the general question of unaccounted-for gas, he gives particulars of the certificates obtained from official inspectors over a period of six years in a district comprising some 1,600 dry meters. The list includes the whole of the meters disputed by the consumers, and also those objected to by the company. He says that a meter disputed by the consumer is as often correct as "fast." Out of a total of 256 meters, 44 were returned *fast,* 64 as *correct,* 8 as *slow,* 32 as *correct,* but passing unregistered gas, 61 as *slow* but passing unregistered gas, and 47 *stopped* and therefore not permitting any test to be made. These tests proved that the loss to the consumer was very slight. Out of the 44 fast meters, only 9 exceeded five per cent., and out of the 256, no less than 140 passed unregistered gas, an advantage to the consumer. The article proves to demonstration that periodical testing would be for the benefit of both buyer and seller of gas.

CHARLES W. HASTINGS.

The Illuminating Engineering Society

Papers Read at the First Annual Convention of the Illuminating Engineering Society, Boston, July 30-31, 1907

The Concepts and Terminology of Illuminating Engineering

PRESIDENTIAL ADDRESS.

By Clayton H. Sharp.

In the infancy of a science the concepts regarding it are necessarily neither very clear nor definite. The terminology of a science always lags far behind the actual state of the science itself. We must have the thing before we have a name for it—we must have the concept before we have a word to express it. An exact terminology, as contrasted with a loose one, is found to be more and more essential in proportion as its concepts develop and as the science itself progresses in exactitude. As long as the treatment of the science is qualitative only, no particular need is felt for an exact terminology. As, however, the science becomes quantitative and involves exact measurements of the quantities entering into it, the need for a terminology which is correspondingly precise is felt. For instance, in the earlier days of the science of mechanics, no strict differentiation was made between the terms force, work and power. At the present time, however, these concepts and the terminology corresponding thereto are very clearly differentiated. The interrelations of things are not seen in the same way when a science is young, as they are when it has, so to speak, reached its maturity. The simplest and most obvious relations are the ones which first are used, and it is only with advancing knowledge that the utility of the less obvious relations comes to be appreciated. This is true for an applied science as well as for a pure science. In the application of scientific principles and industrial products to the uses of every-day life, it usually happens that the practitioner at first proceeds in a purely empirical way. He is likely, however, very soon to find a need for greater exactitude in his work; consequently his terminology, which at first was of the crudest description, becomes more exact and perhaps more complex. His concepts of what he is working with, which at first are inexact and hazy, necessarily become cleared with time; and he finds that the ideas on which he proceeded at first, while they may have been more or less correct, yet are not the ones which are most useful in the more extensive practice which time has brought. It may be useful to illustrate these abstract ideas by a few concrete examples.

Going back into the history of electrical science and of electrical engineering, we find that the earliest electrical conception was that of a force, or tension or pressure. The idea of such a thing as a flow of electricity did not become established until after Volta's discovery and the pioneer work of Davy, Farady, Ohm and others had brought this concept to light, and in Ohm's law a relation between the fundamental electrical qualities was established. It was very many years before the terminology of electricity became in any sense systematized or exact. When, however, electricity ceased to become a pure science and came to be applied to the very practical problem of artificial illumination, so that electric power was generated in large quantities and became a commercial product, the need for a terminology, and for units of measurement and for measuring

instruments, all made themselves felt, and the terms volt, ohm, ampere and watt came quickly into existence and into the everyday language of the science.

The science of magnetism furnishes another example. The obvious thing about a magnet is its attractive force for other pieces of iron. This force is concentrated at points near the ends of the magnet, which points received the name of "poles." When investigators began to study magnets critically, the most apparent thing to do was to measure the force or strength of these poles. On measurements of pole strength the whole science of magnetism was based. The theory of magnetism, however, went on in its development, and the ideas of lines of force and of flux of magnetism were introduced. Later, when magnetic calculations became a feature in the commercial design of dynamos and motors, the old precept of pole-strength was found to be too awkward and cumbersome as a basis for making such calculations and had to be abandoned in favor of the newer one of magnetic flux, doubtless to the great temporary inconvenience of those to whom the pole-strength concept was a familiar one and the magnetic flux concept an unfamiliar one, acquaintance with which was to be gained only at the expense of considerable mental effort and inconvenience.

We are led now to ask what is the state or condition of the science of illuminating engineering in regard to its terminology and its concepts? This science is founded on the ancient science of optics. All the optical principles which apply to illuminating engineering have been known for many years. Optics is, in many respects, an exact science. The laws of reflection, refraction, diffraction and polarization have been studied with minute care. The measurement of wave-lengths and angles of rotatory polarization, as well as the computation of lenses, mirrors and otner optical apparatus, have been carried to an extraordinary degree of precision. In spite of all this, however, the science of optics has remained in a rudimentary condition in so far as its terminology and concepts relating to light as an output, used for purposes of illumination, are concerned.

Just as in the case of magnetism, where the elementary notion of pole-strength was long regarded as the fundamental point of departure for calculations, so the strength or intensity of light sources has been the principal concept in dealing with light as a product. Until touched by the quickening hand of practical application, until illuminating engineering began to take its place as a quantitative science, measurements of the candle-power of luminous sources were all that were required, and by candle-power was usually meant the candle-power in a given direction. At the present time there are many signs that this branch of optical science is following the same course of progress which magnetism has taken before. Within a very few years the term "mean spherical candle-power" has come into use among engineers. This marks a distinct advance in the practical application of illuminating engineering, since it implies a recognition of the difference between a candle-power in a given direction and the average candle-power in all directions in space. The notion of intensity of illumination, as distinct from intensity of a luminous source, has become a familiar one and an awkwardly named unit for it has been used. These are sure indications of the practical progress of illuminating engineering.

What should be, or are likely to be, the lines of further development? These may be determined, in some directions, largely by action which our Committee on Nomenclature and Standards may take. In other directions this committee will be impotent, since it cannot enforce the adoption of its recommendations in practice. The practitioner must feel the need of some novel term or idea before he will adopt such term or idea. Such a need is sometimes unfelt because the practical value of novel terms and concepts is not clearly enough recognized by those to whom they would be useful. Having this in mind, I desire to bring to your closer attention the bearing of some terms and concepts which have not, I believe, established themselves in the practice of illuminating engineering to the extent to which their practical convenience and utility entitle them.

At the present time, in his quantitative work, the illuminating engineer deals chiefly with candle-power in its various aspects and with intensity of illumination. He does not, as a rule, employ any term which expresses directly the quantity of light which is being emitted by the source with which he is dealing. This is surprising, for the quantity of light which he had at his command is of vital importance to him. The distribution of this light he can arrange according to his own wishes by the use of various devices. Now the proper term for the quantity of light is easily

found by a consideration of the physical nature of light itself. Light consists in ether waves propagated with a velocity of 300,000 kilometers per second. A source of light is simply a wave-maker. It agitates the ether continually and sends out a constant stream or flow of such waves in all unobstructed directions. If we take any transparent plane on one side of which is a source of light, we may think of a continual flow of wave-trains in the ether across this plane. If we surround our source of light by a closed, transparent surface, say an imaginary sphere, the total flow of ether-trains through this surface measures the luminous output of the source. For the sake of uniformity with the usages of other branches of physics, etc., the wave-flow is referred to by using the Latin name for flow, namely "flux."

We should form a concept, then, of all sources of light, whether primary or secondary, as the starting points of a luminous flux, and of all spaces surrounding such sources of light as traversed by this luminous flux. Having formed the concept of luminous flux, the following definitions and relations are a direct consequence: The output of any lamp is measured by the total luminous flux which it emits; the brightness of a diffusely reflecting or transmitting surface is proportional to the luminous flux which it emits per unit of area; the reflecting or transmitting power of such a surface is the ratio of the luminous flux which it emits to that which it receives; the intensity of illumination on any surface is the flux which it receives per unit of area. All the above quantities are of vital importance in illuminating engineering, in view of which fact it would be surprising if the concept of luminous flux should not prove itself to be very useful in the every-day work of the illuminating engineer.

It is necessary first to define a unit in terms of which luminous flux is to be measured and to establish its relation to the unit of luminous intensity, the candle-power. This is done in a way analogous to that employed in magnetism and electrostatics; that is, unit flux is defined as the flux emitted by a light of unit intensity, or one candle-power, in a unit solid angle. A unit solid angle is the solid angle subtended at the center of a sphere by a portion of the surface of the sphere bounded by four lines, each equal in length to the radius of the sphere. There are 4π or 12.57 such solid angles in the entire sphere. This being the case, we have approximately the relation that a unit solid angle is the one subtended at a point by a surface one foot square, one foot distant from that point, or by a surface one meter square one meter distant from the point, or a surface one yard square one yard distant from the point, etc. If at the apex of such a solid angle a light source of one candle-power be placed, a unit luminous flux will pass through any transverse plane through the solid angle, no matter what the inclination of the plane or its distance from the light. In terms of this unit, luminous flux is measured.

The relation between the total luminous flux of a source of light and the mean spherical candle-power of that source is at once seen. If we consider a source of light having an intensity of one candle-power in all directions, its mean spherical candle-power would be one; and since there are 4π solid angles in a sphere surrounding that source, the total flux from it will be 4π unit of flux. If the mean spherical candle-power of a source is I_s, its total flux will be equal to $4\pi I_s$ or ϕ equals $4\pi I_s$ where ϕ represents the total flux and I_s the mean spherical intensity. Thus the total flux is numerically equal to 12.57 times the mean spherical candle-power of the source.

We have next to consider the relations existing between flux of light and intensity of illumination. As we have seen, the flux falling on a plane surface one foot square placed one foot distant from a light of one candle-power is approximately a unit flux. But the illumination on that surface is unit illumination if we measure in English units. If the same plane surface is removed to a distance of two feet from the light, only one-fourth of the total flux falls on it and the illumination is one-fourth as intense. In other words, the intensity of illumination on any surface is measured by the luminous flux per unit of that surface or by the flux density. This relation may be expressed thus: $E = \frac{\phi}{8}$

From this relation the familiar inverse square law may at once be deduced.

The above equation becomes of practical importance in computing average illumination results. If, for instance, we know that from a given source or sources of light a certain flux falls upon the plane of reference, we can determine at once the average illumination on this plane by divid-

ing the flux by the area of the plane. Thus the average illumination is determined without direct reference to the candle-power of the sources. Conversely, measurements of illumination on a given plane enable us to determine the flux of light falling on that plane. This is a quantity of great importance, since it leads us to a value for what we may term the net efficiency of the installation, or the efficiency of utilization of the light. By the net efficiency of the installation, or the efficiency of utilization, would then be meant the ratio of flux which falls upon the horizontal plane of reference, to the total luminous flux emitted by the lamps in the room.

In order to make the use of the notion of luminous flux, a convenient one in practical work of the computation of illumination, it is necessary to use it also with reference to the sources of light employed. In other words, when we wish to arrive at average values for illumination rather than exact illumination curves, we may ignore the candle-power and the distribution of the luminous intensity of the lamp and may start out from a value for the flux of light which the lamp, together with its reflector or globe, sends in the direction of the plane of reference. Multiplying this flux by the number of lamps, and dividing it by the area of the plane, we have approximately the illumination on the plane, neglecting reflections from walls and other objects. The effect on the flux of multiple reflections by the walls of the room can be found according to the usual procedure, that is, the flux must be multiplied by $\frac{1}{1-K}$ where K is the average coefficient of reflection of the walls and ceiling, and where this value is subject to large modifications according to the location of the lamps in the rooms. The maximum and minimum points of illumination in a given installation can usually be told at a glance, and the values of these illuminations can be computed if required. The advantage of the procedure outlined above is that it gives an average value for the illumination over the entire plane of reference without the necessity for going through the computation of the actual illumination at a large number of points in the room.

The procedure for determining the value of the luminous flux from a lamp, either its total flux or the flux within a certain solid angle, is similar to that pursued in determining the mean spherical candle-power and mean hemispherical candle-power, etc. For instance, the well-known Rousseau diagram, so generally employed for the determination of mean spherical candle-power, is really a flux diagram. If the Rousseau diagram extends over 180 degrees polar distance, the total area which it encloses is proportional to the total flux of light from the lamp and the part which is enclosed between any two angles as marked on the axes of the abscissas, is proportional to the flux from the zone or from the solid angle. Consequently, any method which will yield the mean spherical, mean hemispherical, or mean zonular candle-power will give, with practically no modification, the luminous flux corresponding thereto. The Matthews integrating photometer may be calibrated so as to give directly the total luminous flux from the lamp measured by it, or other integrating devices may be employed. By the use of such devices as are at hand to-day, it would not be at all impossible to rate lamps according to their total luminous flux rather than according to their candle-power. Thus at one stroke the difficulty would be cleared up which arises from the actual difference in performance of incandescent electric lamps, which are rated alike according to our present arbitrary method. Using one of the methods indicated above, it is a matter of no difficulty to determine what the total flux of light will be, for instance, from a lamp with a conical reflector inside the angle subtended by the sides of the cone. Imagine, then, a number of lamps with such reflectors illuminating a room, and so placed that the angles of the cones of the reflectors do not in any case fall outside the boundaries of the plane of reference. Then the total amount of light which these lamps are throwing on the plane of reference will be approximately equal to the number of lamps multiplied by the flux which is sent out inside this plane, and as said above, the average illumination is obtained by dividing this flux by the area of such plane. This method is of such extreme simplicity that it seems that it ought to be developed in practice. It is concededly approximate, but since any method yields results which are so strongly affected by the reflections from walls and ceiling, it is a question whether an approximate method like this might not in the end yield results which are quite as reliable as those which are obtained by the

more laborious calculations involved when illumination curves are computed.

Having pointed out certain reasons why the notion of luminous flux should find extensive application in illuminating engineering work, let us consider for a moment the question of terminology. We have at the present time a name for the unit of luminous intensity. We call that the candle, and we measure luminous intensities in candle-power.

It is usual in this country to express illumination in terms of the candle, and of the foot as the unit of distance. We have no suitable name for this unit of illumination; by some it is called the candle-foot, by others the foot-candle. Some make the plural candle-feet, others make it foot-candles. The name is inappropriate and awkward, since ordinarily, when we place two words in conjunction like this, we mean the product of the two quantities involved, as for example in foot-pounds, where we mean the product of the feet by the pounds. The foot-candle or the candle-feet, however, means candles divided by, not feet, but feet squared; consequently the term is doubly inappropriate. It would, therefore, be very desirable, if we are going to adhere to this unit of illumination, to have a suitable name for it. If we use the metric system, a name for the unit of illumination is at once at hand. In this system the candle may be the unit of luminous intensity, but the meter is taken as the unit of length. The illumination produced by one candle at a distance of one meter is called the "lux." On account of the relation existing between the foot and the meter, it happens that the lux is about ten times the size of the foot-candle. To be more exact, it is $\frac{39.37^2}{12^2}$ or 10.8. The use of the lux, however, involves the use of an unaccustomed unit of length and it is consequently found awkward. This is all a matter with which the Committee on Nomenclature and Standards will undoubtedly deal.

When it comes to the unit of flux of light, as we have seen, the unit of length does not enter. The unit of flux depends only upon the chosen unit for luminous intensity and consequently we may adopt the name which has already been suggested and used for this purpose, namely, the "lumen." By the lumen we mean the flux of light emitted by a source of one candle-power through a unit solid angle, and, as we have seen, the number of lumens falling on a surface, divided by the area of the surface in square feet, will give the illumination in foot-candles, or the number of lumens falling upon a surface, divided by the area of that surface in square meters, will give the illumination on that surface in lux. It would, therefore, seem to be an obvious thing to do to adopt the lumen as the name for the unit of luminous flux.

A point in terminology, which it may not be out of the way to bring up at the present time, relates to the use of the term "efficiency" in illumination work. We have in this kind of work at least three kinds of efficiency to consider. We have, first, the efficiency of the illuminant as such; second, the efficiency of the illumination installation irrespective of the lamp (this may be called net efficiency of the installation, or the efficiency of utilization of the light); and, third, the efficiency of the installation including the lamp (this may be called the gross efficiency of the installation). The efficiency of the lamp, if it be an electric lamp, would properly be determined by its lumens per watt; this term has not come into use, but deserves to do so. Instead of lumens per watt, we speak of watts per candle. Watts per candle measures for a given type of lamp, the specific consumption of that lamp. True specific consumption would be measured by watts per lumen. The term watts per candle, while a very convenient one from the lamp-maker's point of view, is not so good a term for the use of the illuminating engineer. It is to be hoped, therefore, that in time lamps will be designated by their efficiencies, and the efficiencies will be expressed in terms of lumens per watt. What we ordinarily at the present day call a sixteen candle-power 3.1 watts per candle lamp would, under that system, have a rating of 163 lumens and an efficiency of 3.3 lumens per watt. In the case of gas lamps, the efficiency could be expressed in terms of lumens per cubic foot per hour.

Going next to the net efficiency of the installation, irrespective of the lamp. This is the efficiency which it is the especial province of the illuminating engineer to attend to. Given any illuminants whatever, there is some best way to equip and to arrange them so as to produce a maximum result in illumination. This efficiency may be expressed in terms of the lumens received on the horizontal plane of reference, divided by total lumens emitted by the lamps. The gross efficiency includes the

efficiency of the lamps themselves. This is the efficiency with which the user of the installation, the man who pays the bills, is most interested. This efficiency can be expressed in terms of lumens on the plane of reference per watt, or per cubic foot per hour expended in feeding the lamps. In the *Transactions* of this Society it has appeared that the need is felt for an expression of the gross efficiency of an installation, since the term foot-candles per watt per square foot has been used for this purpose. Those who have used this term have recognized its awkwardness as well as its usefulness, and it has even been proposed to give a name to this unit. If we stop, however, to analyze this expression, we see that foot-candles per watt per square foot is equivalent to foot-candles multiplied by square feet, and divided by watts. But, as we have seen, the foot-candles multiplied by the square feet gives the luminous flux in lumens, consequently the expression foot-candles per watt per square foot is equivalent numerically to lumens per watt; so that here again the introduction of the notion of luminous flux, and of the term lumen, justifies itself by reducing an expression of unusual complexity to one of very great simplicity.

This address as a treatise on the concepts and terminology of illuminating engineering is necessarily indefinite and incomplete. Its purpose is to point out the utility of certain ideas and names which should prove useful in the pursuit of the theory and practice of illuminating engineering. What the ultimate developments will be in concepts and terminology of the science cannot be foretold; the most obvious steps in advance are those outlined above.

Illumination Photometers and their Use

By Preston S. Millar.

In this discussion, instruments which measure the chemical or calorific effects of light are not considered. The illuminating engineer is concerned more particularly with instruments designed to aid the eye in determining the illuminating effect of light. These may be classified broadly as photometers dependent upon visual acuity, and those in which the illumination to be studied is compared to that produced by a standard light source.

Visual Acuity Photometers.

The principle of visual acuity, as generally applied, depends upon the detection of the vanishing point of an effect produced by the light to be studied. In some cases it is the disappearance of a figure or character; in others, the disappearance of a contrast. Such instruments, being based upon the ability of the eye to see or distinguish objects, yield results which are proportional more nearly to those qualities of light which make for visibility, than to its intensity. They are known as visual acuity photometers, or illuminometers.

There are fundamental difficulties with this extinction method which render it unsuitable for important work. These are the inability of the eye to judge of the point of disappearance with precision; the susceptibility of the eye to influence of environments and conditions; the necessity for reducing the light to low intensities at which the "Purkinje effect" operates to distort results; and the errors encountered in effecting this reduction.

The decided advantages which this method can boast are simplicity, absence of expensive adjuncts, and minimum demand for technical knowledge and skill on the part of observers.

Illumination Photometers.

The only photometers which may be relied upon in engineering work to yield reliable values are those in which a comparison light source is used, and reliance is placed upon the ability of the eye to judge equality of illumination. The essential features of such photometers are:

First, a photometric device.

Second, a comparison light source.

Third, a means of varying the intensity of the illumination produced upon the photometric device by the comparison light source.

Fourth, a test plate upon which the unknown light falls.

Photometric Devices.

These may be divided into three groups: First, arrangements of prisms whereby surfaces illuminated by the comparison and the test light sources may be viewed in one field with indistinguishable line of separation. Such devices are characterized by maximum sensibility and ease of comparison, but are generally difficult and expensive of construction. Particularly with low intensities they are superior, working with fair sensibility on intensities quite below the range of other devices. The Lummer-Brodhun photometer is a notable example of devices of this kind.

Second, screens of varying translucency, the opposite sides being illuminated by the comparison and test sources respectively, and being viewed through prisms or mirrors in contiguous fields. The Bunsen photometer is the well-known example of this class of photometric devices. Various adaptations of the Bunsen photometer are used very largely in photometric work in this country. In general, they fall but little short of the prismatic devices of the first class in respect to sensibility and ease of comparison, and are simple and inexpensive of construction.

Third, the various devices whereby the illumination intensities produced by the comparison and test light sources respectively are viewed in contiguous fields with well marked line of separation. In this class may be found the Bouguer screen, the Ritchie wedge, the translucent blocks of Elster and Joly, and other means of comparing illumination intensities, all of which are simple and inexpensive of construction, but lack in sensibility and ease of comparison.

Other photometric devices will be found described in text-books on photometry, but they do not merit serious consideration at this time, in most instances failing to equal those described in point of either accuracy, reliability or simplicity. Of these the flicker photometer is noteworthy. The difficulty in manipulating it and its inapplicability to electric lighting by alternating current make it unsuitable for use in illumination photometers.

Comparison Light Sources.

These are found in great variety in photometric work. They may be classified broadly as flame sources and incandescent electric lamps. Among the flame sources two deserve special mention. The pentane lamp, the legal standard of light in Great Britain, is used largely by gas companies in laboratory practice as a primary standard of light. The Hefner amyl-acetate lamp, the legal standard of light in Germany, is used largely in Germany as a primary standard of light, and is used somewhat in this country in both laboratory and portable photometers. In addition, kerosene, benzine and gas burners have been used in photometers as secondary standards of light. The pentane and Hefner lamps as primary light standards give results of considerable precision when used in the laboratory, under carefully controlled conditions, and manipulated by those who are expert in their use. In common with the other flame sources used as secondary standards in portable photometers, but little in the way of precision and reliability can be expected. They are all so dependent upon uniform conditions of burning as to be unreliable when used where they are moved about the room, or where they are liable to changes in atmospheric conditions and in drafts. The fire risk which they entail is a strong objection to their use. The only place which they should have in the measurement of illumination is in connection with photometric apparatus which lays no claim to high precision, and in which simplicity of construction, absence of measuring instruments and source of energy supply, constitute an advantage which overbalances the superior accuracy obtainable with the incandescent electric lamp properly used. Such a field flame sources undoubtedly fill, offering a means of determination considerably superior to that obtainable with photometers based upon the visual acuity method.

With the incandescent lamp used as a secondary standard of candle-power, most favorable photometric conditions may be obtained. Its use, however, necessitates a source of current supply and a means of determining with fair precision the voltage at which it burns, or the current which it consumes. Under these conditions it may be relied upon to remain constant for a limited period, during which time it constitutes the most reliable, accurate and satisfactory comparison light source.

Means of Varying the Intensity of Illumination Produced Upon the Photometric Device by the Comparison Light Source.

This has been accomplished by a variety of methods, some of considerable ingenuity. These may be classified as follows:

First, variation in distance, applying the inverse square law.

Second, rotating disks, relying upon Talbot's law.

Third, inclination of an illuminated surface, applying Lambert's law of the cosine.

Fourth, variation of the intensity of the comparison light source.

Fifth, the use of absorbing media.

Sixth, the use of variable diaphragms, generally with diffusing screens.

Seventh, dispersion lenses.

Eighth, polarization method.

Of the above, the variable distance method is, in the opinion of the writer, superior in that it possesses accuracy, reliability, ease of verification, calibration according to

a known law, simplicity, a wide range and universal applicability. No other one method possesses all of these advantages.

The properties of the rotating sectored disk have been investigated on a number of occasions, perhaps most recently by Dr. E. P. Hyde. This is an excellent means of varying the intensity of light, but lacks somewhat in simplicity where it alone is relied upon. It is possible that under some conditions errors might be introduced by this method when applied to alternating current electric lighting, and to some other forms of lighting in which periodical flickering phenomena are encountered.

The variation of the inclination of a plane with reference to the light incident upon it, or to the angle at which it is viewed, is an unsatisfactory method; first, because unless a perfect diffusing surface is obtained, the cosine law will not apply, and the instrument should be calibrated empirically; second, because any surface which approximates a perfect diffusing surface is likely to change in character, which would introduce an error into the scale calibration of the instrument; and third, because the scale calibration of an instrument in which this is used becomes very narrow with low intensities, so that the slightest displacement of the plane will produce a marked difference in the illumination in the region where the photometric comparison is rendered difficult because of the low intensity which is being studied.

Two methods of varying the intensity of the comparison light source have been used; in the one, adjustable opaque screens expose a greater or lesser portion of the luminous body. This method is particularly applicable when flame comparison sources are used. The other method consists in varying the intensity of the source itself—with flame sources, by wick-adjustment, and with electric lamps, by varying the current flow. This method is unsuitable for use with flame sources, because it is necessary to wait some time after an adjustment is made, before a constant luminous intensity is obtained. With electric lamps it is objectionable because the satisfactory range throughout which the method may be applied is of necessity small, since with very low intensities the color value becomes altogether objectionable, and with higher intensities the lamp must be operated at so high an efficiency as to endanger its constancy.

Absorbing media offer an excellent and very practicable means of varying the light intensity, but must be selected carefully in order to guard against errors due to selective absorption. Properly selected, they form an excellent adjunct to a photometric system. If, however, they have any marked tendency toward selective absorption, they must be used very intelligently, or errors will be introduced. While it is possible to construct absorbing screens which may constitute a complete device for varying the intensity, yet this method has found its best application in varying the intensity by large steps where supplementary means are provided for effecting finer variations.

The comments in the previous paragraph apply as well to the use of absorbing screens with variable diaphragms.

Dispersion and polarization methods are but little used in this country in photometry of the class now under discussion. The writer has had no experience with these methods, but since obviously superior and more practicable means are available they would seem to merit but little consideration.

The Test Plate.

In general work the intensity of the light incident upon a given surface is the only quantity which it is practicable or even desirable to measure. This is not proportional necessarily to the illuminating effect, which varies as well with the point from which the surface is viewed, with the color of the light and with the color and character of the surface.

The criterion by which the light intensity is judged must be strictly proportional to the light incident upon the test plate, and must be independent of each of the other improper variables just mentioned, if the results of the observation are to show the intensity of the light incident upon the surface.

Whether or not the light falling upon the photometric device varies only with that incident upon the test plate, depends upon the design and location of that plate. Consequently there is no feature of an illumination photometer more deserving of the attention of its designer. But, strange to say, in this particular, many instruments are badly designed and liable to large error.

The requirements for a theoretically correct test plate are:

First, a plane white surface which, when viewed from the point of photometric observation, obeys Lambert's law of the cosines with reference to intensity of illumination produced by light incident upon its

surface at any inclination and from any direction.

Second, a material which will not introduce errors due to color differences.

Third, a plate which may be placed at any angle.

Fourth, a location such that neither the body of the observer nor instrument parts shall obstruct light which would otherwise fall upon the plate.

The character of the surface upon which the effect is studied, naturally influences the results materially. If it were to consist of a mirror in which practically all of the reflection is regular, the value assigned to any light incident upon its surface would vary from 0 to 100 per cent. depending upon whether it was viewed from a point within or without the field of regular reflection. If the surface were glazed, light incident upon it at angles of sharp inclination would suffer or profit unduly through regular reflection, the nature of the effect depending upon the point from which the surface is viewed. Hence it is necessary to secure a plane surface which shall be as nearly as possible a perfect diffuser of light, in order that light incident upon it at any angle may be credited with its true intensity, and only its true intensity. Unfortunately there is no available surface which accurately meets these requirements. Therefore, in selecting a surface, the requirements must be kept in view as an ideal, and must be approximated as closely as may be possible.

Until it shall be found possible to use a true diffusing surface, results must vary with the direction from which the test plate is viewed, unless it is studied by reflected light from a point directly above the center of the plate, or by transmitted light from a point directly beneath the center of the plate. The first is obviously impossible, because it would necessitate interference with light which would otherwise fall upon the test plate. It follows, therefore, that the correct method is to consider transmitted light from a point directly beneath the test plate.

It is, of course, desirable to measure all of the light which would be incident upon an object at the point to be considered. In all interior lighting systems there is more or less diffused light, all of which has some illuminating value. In order to measure all of the effective light, there must be no objective interference with light incident upon the plate at any angle. This means that all instrument parts, as well as the observer, must be beneath or behind the surface of the test plate. This is possible only when transmitted light, instead of reflected light, is measured.

The illuminating effect of any lighting installation may be a function of the horizontal, vertical or normal illumination produced, while a study of the illumination produced upon surfaces otherwise inclined adds data of value and interest to any investigation. The necessity for providing simple means for placing the test plane at any desired angle is therefore apparent.

The introduction of differences in color values complicates photometry seriously. If the light from the mercury vapor lamp were to be studied upon a red surface, its illuminating effect would be no criterion of the light intensity. Hence the only color which is practicable is white, of as great purity as may be obtainable and as free as possible from selective absorption. With such a test plate, lights of different colors are credited with approximately their true intensities, when the test plate is viewed from the photometric device.

The Ideal Photometer.

It appears, therefore, that in building a photometer, the designer has a choice of many photometric devices, comparison light sources and means of varying the light intensity and effecting the photometric comparison. With respect to the test plate there should be no choice. It should have a plain white diffusing surface; it should be translucent and viewed from directly beneath its center; it should be capable of location at any angle, and should be so located that all instrument parts and the observer are beneath or behind it.

In the ideal photometer, such a test plate would be found combined with the most sensitive photometric device, the most reliable comparison light source and the best means of varying the intensity. These features should receive first consideration, for reasonable precision ought to be the first desideratum. Next in importance comes portability, simplicity of operation and reasonable cost. If there were any necessity for sacrificing reasonable precision in order to secure other desirable qualities, some compromise might seem advisable, but since this is not the case there can be no objection to adherence to the ideal, as set forth above.

As there is an insistent demand for an illumination photometer which shall be both reasonably accurate and thoroughly practicable, it is felt that a discussion of the

instruments which have been designed with this in view will be of interest to the membership of this Society. In the following paragraphs will be found brief illustrated descriptions of eleven photometers. Only the essential features of each are touched upon. The cuts are lettered similarly in order to facilitate comparison. Thus A indicates the test plate, B the photometric device, C the comparison lamp and D the means of varying the intensity.

Illumination Photometer, Designed by Walter Beckstein.

Fig. 1 shows a plan of the photometer. The test plate A is placed at the point where it is desired to study the illumination. This plate may be rotated throughout a vertical plane about the photometric device

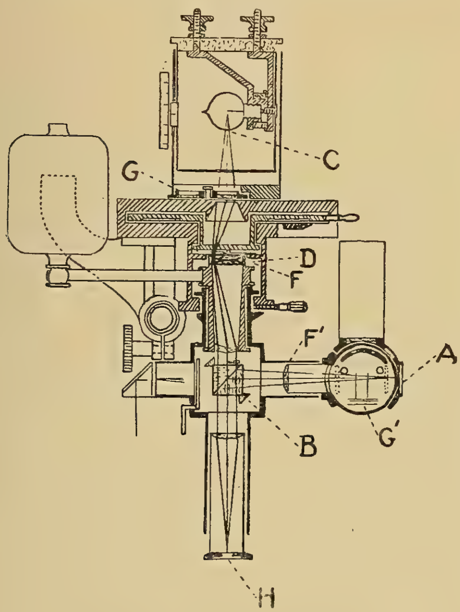


FIG. 1.—BECKSTEIN PHOTOMETER, SECTOR TYPE.

B as an axis. B is a Lummer-Brodhun cube through which the lower surface of test plate A is viewed. Through the prisms B may be viewed also translucent plate G, which is illuminated by the comparison lamp C. Equality of illumination is obtained by viewing the plate G through a portion of lenses F which may be rotated. At position D is placed a variable sector disk about the axis of which the beam of light is rotated by the lenses F. The result of the photometric setting is obtained from the size of opening of sector disk D which is necessary in order to obtain equality of illumination. This device is in effect, a rotating sector disk except that the beam of light instead of the sector, is rotated, thereby facilitating precise adjustment of the sector disk.

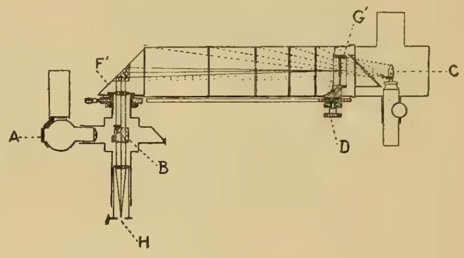


FIG. 2.—BECKSTEIN'S FORM OF WEBER PHOTOMETER.

Illumination Photometer, Designed by Walter Beckstein.

This photometer, of which a plan is shown in Fig. 2, is a modification of the Weber photometer and simpler in construction and less costly than the photometer described in the preceding paragraph. The test plate and prism arrangement are similar, but the comparison lamp C is a benzine lamp, and equality of illumination is obtained by movement of translucent screen G by means of rack and pinion device D along a tube, its intensity of illumination varying inversely as the square of the distance from lamp C. Results of photometric settings are read off directly from a scale along the tube through which plate G′ travels.

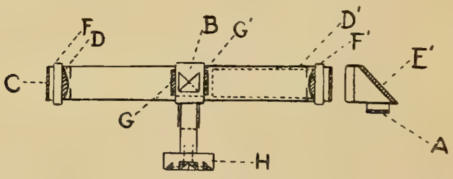


FIG. 3.—BLONDEL & BROCA'S PHOTOMETER.

Illumination Photometer, Designed by Prof. Andre Blondel and Broca.

Fig. 3 shows a plan of the photometer. That portion of the light which is transmitted through test plate A is reflected from the 45 degree mirror E′ through lens F′ upon ground plate G′ (which forms part of the photometric device). Before lens F′ is placed "cat's-eye" diaphragm D′. A comparison light source C which is not described is placed to the left of the apparatus.

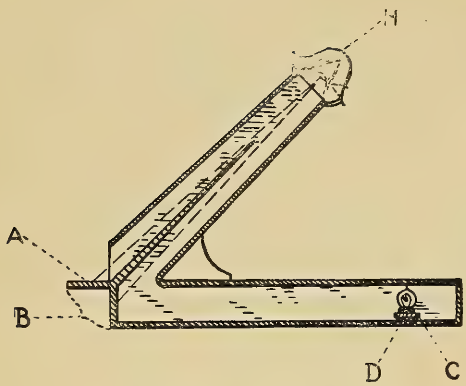


FIG. 4.—BURNETT'S PHOTOMETER.

Its light passes through lens F and falls upon ground glass G. This is varied in intensity by the adjustable "cats's-eye" diaphragm D. The photometric device B consists of crossed prisms through which ground glass plates G and G′ are viewed from the binocular arrangement H. Equality of illumination is produced by adjustment of variable diaphragms D and D′ which are equipped with means for indicating the size of the aperture.

Illuminating Power Photometer, Designed by Douglas Burnett.

A vertical section is shown in Fig. 4. The light which is to be studied falls upon test plate A, which is one surface of a photometric wedge. The other surface of the wedge is illuminated by comparison lamp C, which travels along the horizontal axis of the box. This lamp is moved by means of a handle D, which protrudes through the side of the box. The two surfaces of the wedge which constitutes the photometric device B are viewed from position H through a box which is divided by a partition which constitutes a well-defined line of separation between the two surfaces of the wedge. Results are indicated on a scale along the horizontal box which is calibrated directly in foot-candles.

"Illuminometer," Designed by J. T. Marshall.

Fig. 5 shows the arrangement of the instrument. The test plate A is also the upper surface of the photometric device B. This consists of a screen of which the translucency is varied by different thicknesses of paper. It is illuminated from beneath by the comparison electric lamp C, the intensity of whose light is varied by means of rheostat D. Lamp C is operated from two dry cells within the instrument, a spring

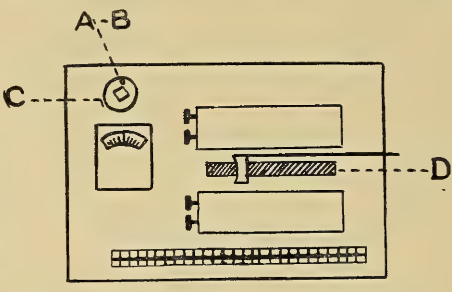


FIG. 5.—MARSHALL'S PHOTOMETER.

switch being placed in the circuit so that the lamp is operated for a minimum time only. To effect a photometric setting, the flow of current through lamp C is varied until disappearance of contrast is obtained at screen B when viewed from above at an angle of about 45 degrees to its surface. The resistance of lamp C is then measured by means of a simple Wheatstone bridge with a portable galvanometer, both enclosed within the instrument. One arm of this bridge consists of an exposed wire, stretched taut. Beneath this wire is placed a millimeter scale. The contact is moved along the exposed wire until the point of no deflection is obtained, and the foot-candles value is then obtained from the scale reading through an interpretation curve.

Illumination Photometer, Designed by Martens.

Fig. 6 shows a vertical section through the instrument. Test plate A which re-

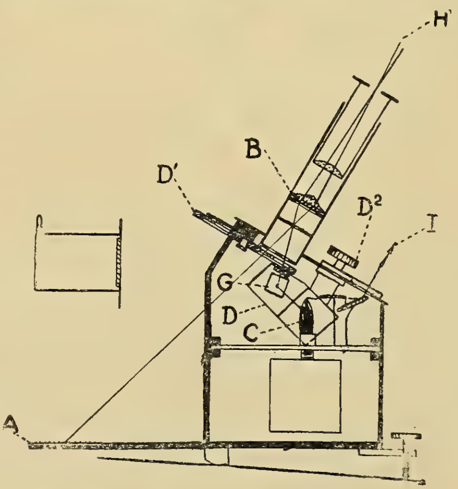


FIG. 6.—MARTENS'S PHOTOMETER.

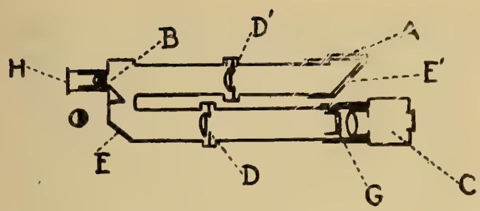


FIG. 7.—MASCART'S PHOTOMETER.

ceives the light to be studied is observed through the photometric device B, through which may be seen also the surface of plate G, which is illuminated by comparison benzine lamp C through a pair of sliding mirrors D. These mirrors vary the distance between lamp C and plate G, being operated from rack and pinion device D^2. Results are read directly from a scale over which plays a pointer attached to D^2.

Illumination Photometer, a Modified Design of the Mascart Photometer.

In Fig. 7 the light to be studied falls upon translucent paper A, which constitutes the test plate. That which is transmitted passes through the 45 degree mirror E', a convex lens, and falls upon the upper half of translucent screen B. A comparison lamp C illuminates translucent screen G. Light which is transmitted through this screen passes through a convex lens, the 45 degree mirror E', the total reflecting prism immediately above E, and falls upon the lower part of screen B, where it is viewed from position H. Both lenses mentioned have adjustable diaphragms D and D, which are used to vary the intensity and effect equality of illumination upon screen B. The adjustment of these diaphragms indicates the result of the photometric settings. Comparison lamp C is a flat flame gasoline lamp. The instrument is standardized by a Carcel lamp whose light falls upon the test plate.

Illuminating Power Photometer, Designed by Sir William Preece and A. P. Trotter.

Fig. 8 shows a vertical section through the instrument. The light to be studied falls upon surface A, which is also a portion of the photometric device B. The comparison lamp C illuminates bristolboard D, which may be inclined at any desired angle. Through slits in surface A, portions of screen D may be viewed. Photometric balance is made by equalizing the brightness of surfaces A and D.

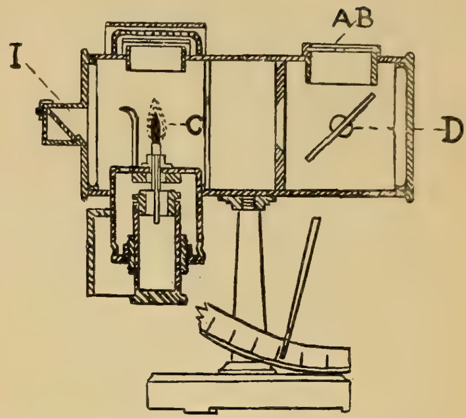


FIG. 8.—PREECE AND TROTTER'S PHOTOMETER.

"Candle-Foot Photometer," Designed by W. D'A. Ryan.

In Fig. 9 the light to be studied falls at A upon one surface of the photometric device B, which consists of a translucent

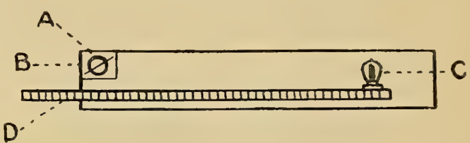


FIG. 9.—RYAN'S PHOTOMETER.

block, divided diagonally by a thin, opaque film. The comparison electric lamp C illuminates the other half of the block. The distance between this lamp and the block is varied by means of rod D upon which is calibrated a scale which indicates the results of photometric settings. The photometric device B is viewed through the side,

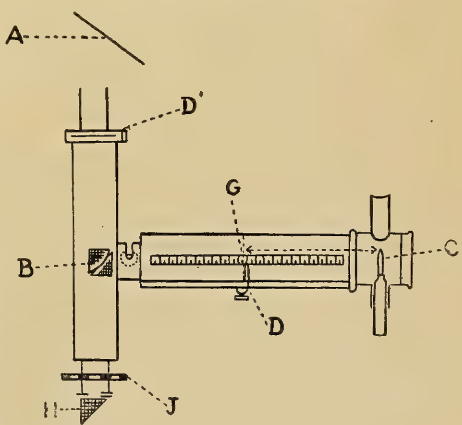


FIG. 10.—WEBER PHOTOMETER.

equal portions of the two halves of the block being viewed.

Weber Photometer.

In Fig. 10 the light to be studied is received upon the portable test plate A, which consists of white cardboard. This is viewed from eyepiece H through a simple Lummer-Brodhun cube B. The light from the comparison benzine lamp C illuminates a traveling translucent screen G, which is viewed from the eyepiece H through B. A unique feature is the use of colored glasses in the ocular tube with a view to comparing illuminants of different color values with respect to those qualities upon which depends the ability of the eye to perceive objects which they illuminate. As has been stated, this is not necessarily proportional to the intensity of illumination.

Weber Photometer—Modified Portable Form.

The Weber photometer is now made in a more portable form, and with some modifications. A vertical section of this instrument is illustrated in Fig. 11. The test

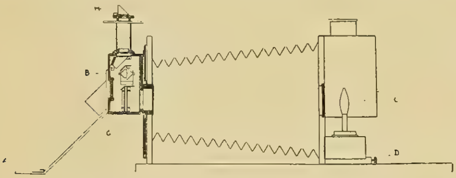


FIG. 11.—PORTABLE FORM OF WEBER PHOTOMETER.

plate A bears a fixed relation to the photometric device B, but may be placed at any angle in a vertical plane, the photometric device moving with it around the horizontal axis of the comparison Hefner lamp. Equality of illumination is obtained by moving the comparison lamp C along the photometric axis. Results appear in terms of a unit of illumination intensity. The range is increased by means of absorbing screens.

Fig. 12 illustrates the errors due to the improper location of the test plate.

As an example, the Martens photometer incorporates many good features, but its designer has largely destroyed its usefulness by giving the test plate an impossible location where the measurement of the total illumination produced in any diffused lighting system is entirely out of the question because the instrument itself obstructs so much of the light.

It was hoped that a number of the in-

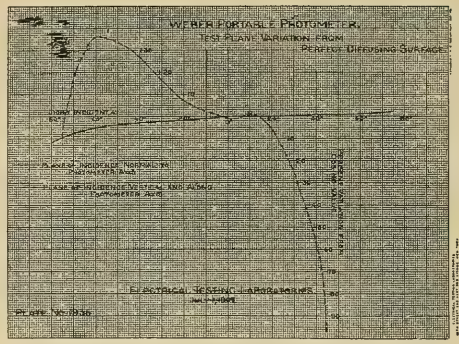


FIG. 12.—CURVES SHOWING ERRORS DUE TO IMPROPER LOCATION OF TEST PLATE.

struments could be obtained for investigation, but some of them are more or less in the experimental stage and their designers were not in a position to offer them for this purpose; however, two of the instruments were tested. The results obtained will illustrate the extent of errors which may be encountered in measuring illumination with instruments which are incorrectly designed.

As respects the sensibility of the photometric device it was found from repeated settings with one of the instruments in which the photometric device is of low sensibility, that no higher accuracy than six per cent. could be obtained. The maximum variations in settings with this instrument were fifteen per cent. below, and ten per cent. above the average.

It was found that in one of the instruments in which a flame source was used, readings could not be relied upon within five per cent. because of flame variations due to drafts, changes in humidity, etc.

In measuring diffuse illumination, where much of the light comes from the ceiling and walls, it was found that with two of these instruments in which the design and location of the test plate were incorrect, results were obtained which were too low by 20 and 29 per cent. respectively. This was due to regular reflection and obstruction of light by the body of the observer or by instrument parts. With the same instruments, change from a black coat to a light coat on the observer, introduced differences amounting to 10 and 18 per cent. The extent of these errors illustrates the necessity for careful design and location of test plate. It is hardly worth while building a photometer which is liable to errors of this character, in addition to any others which may be entailed by the use of improper comparison light sources, low sen-

Extent of Errors Due to Improper Design or Use of Illumination Photometers as Judged by Errors Found in Certain Models.

Photometric device of low sensibility	6 to 10 per cent.
Flame source as comparison lamp	3 to 5 " "
Direct comparison method neglecting personal equation	13 to 34 " "
Improper design and location of test plate when measuring diffuse illumination	20 to 29 " "

sibility photometric arrangements, and errors in varying the intensity of the light from the comparison light sources.

As an illustration of the possibilities of errors entailed by reliance upon the direct comparison method in which a standard lamp is used directly in comparison with the test source, it was found that with one of the instruments, seven skilled observers, who, however, were not familiar with the particular instrument under test, obtained values which varied from 21 per cent. below to 34 per cent. above the value which was considered to be representative, namely, the mean of the results of the seven observers. The average variations of these observers from such mean was 13 per cent.

While it is unlikely that there would be incorporated in any one instrument all of the bad features referred to, yet all of the photometers listed above fail to meet theoretical requirements in one or more particulars. The errors found in some of the models are therefore listed in the above tabulation for reference.

The Use of Illumination Photometers.

In the measurement of illumination, either of two general methods may be followed. The first is the direct comparison method in which a primary standard of light is used, or a secondary standard of light is used as a primary standard, so far as the instrument is concerned. The Hefner lamp, more than any other light source, is used in this way. Or an incandescent electric lamp may be standardized to yield a certain candle-power and may be used, as is the Hefner lamp, for direct comparison purposes. Such a light source is located at a definite distance from the photometric device and is calculated to produce a fixed intensity upon that device. This method has the great advantage that it permits an instrument to be more nearly self-contained, and to be used without reference to any other light sources. However, it is liable to serious objections in that all changes in the comparison lamp, as well as any misplacement of parts are likely to introduce errors for which no compensation is made. Furthermore, the method makes no allowance for the personal equation. The second, and superior, method is commonly known as the substitution method. This covers a multitude of photometric sins. Here the comparison light is strictly secondary and is standardized and verified from time to time by other standards of light so placed as to produce upon the test plate illumination of known intensity. By this method changes which would introduce errors where the direct comparison method is used, are compensated for either entirely or in part, since every effect which they produce upon the measurement of light from a test lamp will be proportional to the effects produced upon measurements of unknown intensities.

It is very important that instruments used in measuring light from any illuminants should be calibrated with reference to light of known intensity from illuminants of similar character. It must be recognized that in many cases this is not practicable. Where it cannot be done, and particularly where the color values or characteristics of the light are widely different from those of the light sources with which the instrument was standardized, the possibility of error should be recognized.

An excellent method of determining the precision of the photometric part of an illumination photometer is to use it in the photometry of single light sources. The instrument designed specifically for the measurement of illumination differs from the laboratory instrument used to measure candle power only in that it is equipped with an illumination test plate and is generally rendered portable and so enclosed that it may be used in a brightly lighted room. Any illumination photometer may be used in a determination of the candle power of light sources if the proper precautions are taken. The light sources and the test plate of the instrument should be so screened that no light except the direct rays from the source under test reaches the test plate. In using an illumination photometer in this way, many large sources of error which attend the measurement of total illumination are eliminated, and it is possible to learn more definitely the degree of precision

obtainable with the instrument used as a simple photometer.

One of the large difficulties in the practical use of an illumination photometer is to be found in the variability of light intensity in most commercial installations. If the installation consists of incandescent electric lamps, this can be dealt with best by operating the comparison electric lamp from the lighting circuit, when its variation will be similar in character, if not in degree, to that of the illumination to be studied. This is known as the "similar circuit method." When an instrument is so designed that this cannot be done, or when the lighting installation consists of other than incandescent electric lamps, it is advisable to continue observations at each test point over a sufficient period to afford a fair average result.

With any of the photometers described in this paper it is probable that the skilled photometrist could approximately correct results, for he would locate the sources of error, determine their extent and apply such corrections as were possible. Most errors in photometry are occasioned by failure to recognize the limitations of instruments used. Recently there has been exhibited a tendency to forget that photometry is a science, and that one may become skilled in its practice only after he has acquired a knowledge of the fundamental principles involved, and has become experienced in the application of those principles. Instruments have been designed which apparently make so little demand for technical skill on the part of the observer as to give rise to the belief that photometry is as simple as is their operation. This has led to the publication of results which would appear to be utterly unreliable, judging from the instruments and methods employed in making the tests. Recent files of the technical press and the *Transactions* of our Society offer testimony to this effect.

It is submitted that this Society, and illuminating engineers in general, must rigidly uphold the best traditions of the past in photometry, and must so apply recently acquired knowledge and experience that a still higher standard may be established. As the photometry of light sources and of illumination has an important place in illuminating engineering practice, we should oppose strongly the recent tendency which has already led to aspersions upon the accuracy of illumination measurements, and which, if followed, must surely bring illumination photometry into disrepute.

In closing, a few maxims are offered, which the illuminating engineer would do well to bring to bear upon photometric problems. If the points are not well taken, it is hoped that the fact will be brought out in discussion.

An instrument must be a good photometer before it can be a good illumination photometer.

Measurement of illumination is more difficult than the measurement of candle-power.

In obtaining a photometric setting one does not necessarily determine the value of the light studied.

Every photometer is to be regarded with suspicion until its accuracy is demonstrated. It is then to be regarded with suspicion until it is shown that no change has occurred since verification.

No photometric information is better than misleading photometric information.

Primary, Secondary and Working Standards of Light

By Edward P. Hyde.

We are living in an age of exact measurement. With what profound wonder would our forefathers have contemplated the marvelous precision of modern physical science. We compare resistances to parts in a million, we weigh weights to parts in a billion: indeed, if it were not for photometry and a few kindred sciences, I am afraid that the term "per cent," which for so many years has been the common unit in expressing accuracy, would soon become obsolete in that sense.

What, we ask ourselves, is the cause of this tardy development of photometry? Is it because our instruments are insufficient, or our standards inadequate, or is there some inherent difficulty that cannot be overcome? To be sure we shall always have the limitations of the human eye to contend with, because "light" by definition is subjective, but oftentimes the eye is made the scape-goat for faulty methods or inaccurate measurements. The accuracy of comparison of two luminous sources of the same color is well beyond that with which the intensity of either can be expressed in terms of our standards. The fault then lies ultimately with our standards.

It is not my intention in this paper to present to you a history of primary standards of light, or to make a study of the relative merits of the various standards in

use at present. It is my purpose, rather, to ask your consideration of a few very practical questions in connection with the relationship of primary, secondary and working standards of light. By a "primary" standard is meant any standard that can be set up from written specifications, such as the Violle platinum standard, or the Hefner lamp or the Vernon-Harcourt pentane lamp. By a "secondary" standard is meant a standard which, though not reproducible, will remain constant after having once been calibrated. The well seasoned incandescent lamp is the best example of this. By a "working" standard is meant any lamp that is used as a standard in ordinary photometric measurements. It may be a secondary standard or even a primary standard, but it is not necessarily either. Though the three classes of standards are quite separate in principle they operlap in practice.

There is one quality which all standards must possess in common. They must have a suitable color. This requirement is very indefinite, but it must needs be so. We cannot specify the actual spectral distribution, but we can exclude monachromatic sources as being impracticable, whereas we cannot assign values of relative merit to those which fall within the wide range of acceptability. In addition to this common property there are special properties which each class of standards must possess.

A primary standard is good or bad accordingly as it is or is not reproducible. Its fitness as a primary standard depends upon the degree of accuracy with which it can be reproduced. It is not necessary that it should remain constant over a long period of use; the time at which the measurements are to be made can be specified, as is done in the case of the Violle platinum standard. It is not even necessary that it should be particularly inexpensive or simple, as it is sufficient that it should be set up from time to time in one or several of the various national standardizing laboratories now in existence. The only absolutely necessary qualification of a primary standard is, that in case all the secondary and working standards should be destroyed, the unit could be re-established. Of course if a lamp can at the same time serve as a primary standard and also as a secondary or working standrd, it is the more valuable. If it is simple and inexpensive so much the better, but these are not necessary qualities of a primary standard.

In a secondary standard we desire other qualities. These are best seen by keeping in mind an example—the well seasoned incandescent lamp. A secondary standard need not be reproducible—we cannot make two incandescent lamps exactly alike; but it must remain constant after having once been calibrated in terms of the primary standard. It should be portable, simple and inexpensive. Every standardizing laboratory should have a number of secondary standards against which to measure the working standards of lamp manufacturers and testing laboratories.

The working standards should be adapted to the particular kind of testing in which they are to be used. In testing incandescent lamps, we want as working standards other incandescent lamps; in testing gas or oil, we want flame standards. Working standards should be portable, simple and inexpensive, easy to manipulate and of suitable intensity, but they need not be reproducible. Having been standardized in terms of secondary standards, they should remain constant over a reasonably long period before having to be recalibrated or replaced.

With this brief statement of the requirements of primary, secondary and working standards of light, let us inquire into the present conditions regarding these three classes of standards. First, is there a satisfactory primary standard of light? I think you will all agree with me that there is not. Many such standards have been proposed from time to time, and at present there are three or four such standards in actual use. This last fact in itself indicates that there is no one standard sufficiently superior to the others to warrant its general adoption. And if we look over the tables of relative values of these different standards and compare the values found at one laboratory with those found at another, or those obtained in recent determinations with those accepted as the best of previous determinations, it is evident that there is an uncertainty in the ratios well beyond the limit of the error of measurement.

The situation with regard to secondary standards is quite different. It is generally conceded that the well seasoned incandescent lamp meets every requirement of a secondary standard of light. The objection that is occasionally raised, that it changes with the time of burning, is not in my opinion as important as the changes which seem to take place at times when the lamp is stored away. A four-watts-per-candle lamp, if properly seasoned, will not change appreciably, *i. e.*, more than two or three parts in a thousand in fifty or seventy-five hours continuous burning. Since it only requires several minutes to measure an incan-

descent lamp, the standard lamp could be measured 500 or 1,000 times before it would change appreciably in intensity. Since at the Bureau of Standards there are incandescent lamp secondary standards that are only used once or twice a year, it is evident that if only the change in candle power due to burning is to be reckoned with, the unit, in terms of which the secondary standards are expressed, could be maintained constant to within two or three parts in 1,000 for several hundred years.

On the other hand there seem to be much larger changes in the lamps from time to time while the lamps are not burning. Occasionally a lamp develops a bad vacuum; at other times a change in resistance is noticed, indicating probably an altered contact resistance between the filament and the leading-in wires. But apart from these changes in candle power, which are accompanied by changes in the electrical properties of the lamps and which can probably be explained, there are apparent changes in intensity which are just over the limit of observational error, and for which we can offer no explanation. In determining the relative values of a number of incandescent lamps that have been intercompared before, one of the lamps may seem to be high or low in intensity, with respect to the mean of the remaining lamps, by a half per cent or more. I do not mean that a single observer with one set of readings finds the lamp off by that amount—observational error might possibly account for that; but the mean of a number of sets by one observer agrees with the mean of a number of sets by another observer, in giving to that lamp a value somewhat different from that which it previously had. In another set of measurements, some time later, the lamp may come back to its original value.

Whether these apparent changes are due to slight differences in the conditions of measurement at different times, or whether they are real changes in the lamps, it would be premature to say at present. They are small, however, and if a number of lamps are used, the mean value should remain sensibly constant over a long period.

The well seasoned incandescent lamp is also an entirely satisfactory working standard in the photometry of electric lamps, but it is not suitable for use in gas photometry. It requires electric power to operate it and electrical measuring instruments to control it, and these are usually not available, particularly in small gas plants. But apart from its inconvenience, it is unsatisfactory. The intensity of a gas flame is a function of the atmospheric conditions, and it would not be practicable to correct all measurements to standard conditions, as that would involve the determinations not only of water vapor and carbon dioxide, but also of the proportion of oxygen present in the atmosphere. In supplying gas, however, it is desirable for the manufacturer to state that the candle power of the gas furnished under normal atmospheric conditions would be up to the requirement. The way in which to determine this, without actually making the corrections, is to have as a working standard a lamp that is affected by the atmospheric conditions in the same way and to the same amount as the gas under test. If the intensity of the standard lamp under normal conditions is known, the candle power of the gas under normal conditions is obtained immediately, by direct comparison with the standard lamp, independent of the atmospheric condition of the photometer room, provided it is uniform throughout the room.

The consensus of opinion among gas engineers is certainly that the working standard for gas photometry should be a flame standard. There seems to be less unanimity, however, in regard to what flame standard should be used. Candles are still used to some extent in the United States and abroad, but recently there has been considerable advancement both in this country and in England in the adoption of the Harcourt ten candle power pentane lamp. In Germany the Hefner lamp is used now to a great extent in gas photometry, I believe, and in France the Carcel lamp continues to be used almost exclusively. But although flame standards have been and still are used in gas photometry, I do not know of any investigation of the relative influence of atmospheric changes on the gas and the standard lamp. It is scarcely justifiable to assume that the coefficients are the same for two such flames as the pentane flame and the gas flame, which are controlled in entirely different ways. The pentane lamp is adjusted for flame height, whereas in much of the gas work the flame of the batwing burner is adjusted to a definite rate of consumption of gas by weight. Recently, in coöperation with the United Gas Improvement Company of Philadelphia, the Bureau of Standards made some experiments along this line in one of the company's gas-testing photometer rooms in Philadelphia. Although these preliminary experiments were not carried far enough to warrant any very definite conclusions, they indicated that the

two flames, the pentane and the gas, are affected in the same way, to approximately the same extent, by changes in the atmosphere. Since differences of eight or ten per cent in the intensity of the standard lamp may readily occur under normal working conditions, it is evident that if results of any accuracy are sought it is not sufficient that the atmospheric conditions affect the standard flame and the gas flame in the same direction; the coefficients of change for the two should be very nearly the same.

Another interesting fact in connection with the working standards in gas photometry is that, with the possible exception of the Carcel lamp which, I believe, has been calibrated in terms of the Violle standard, all of the lamps used as working standards are at the same time primary-standards. In the photometry of electric lamps the seasoned incandescent lamp soon came to be used as the working standard, since the primary flame standards were not convenient. But in the photometry of gas, since a flame standard was desired, the primary standards came to be used as the working standards. Although this is a logical result, it is questionable whether it is the most satisfactory one.

Is it not possible that a cheap and portable lamp which would remain constant in intensity after having been calibrated might be found which would be more convenient and more easily manipulated than the Harcourt pentane lamp, for example? It does not follow that the lamp which best satisfies the requirements of both a primary and a working standard will satisfy the requirements of a working standard alone better than any other lamp. In other words, the lamp which is best with respect to both constancy and reproducibility need not be the most constant lamp, if reproducibility is eliminated. With authoritative testing laboratories available, where secondary standards are maintained, it is no longer necessary that the primary standards should be used in industrial photometry.

I have no such lamp to suggest as a working standard for gas and it is possible that none can be found, but I think it is well to divorce the functions of the two kinds of standards. Reproducibility is the chief requirement for a primary standard, and constancy with burning is only a convenience. With the working standard, reproducibility is of no consequence; the lamp, however, should remain constant while burning, thus maintaining the candle power assigned to it on calibration. If the lamp which is the most reproducible is the most constant and convenient, then use it as a working standard, but do not confine the search for a working standard to those lamps which are reproducible.

The use of a primary standard as a working standard may, however, lead to a confusion of units between the gas and electric industries. This is exemplified by the situation in our own country at present. Both in the photometry of gas and of electric lamps the intention was to use the British parliamentary candle. The American Institute of Electrical Engineers recommends obtaining the candle through the Hefner by the use of the ratio one Hefner equals 0.88 candle, which was supposed to be the mean value of the best determinations of that ratio. In gas photometry the sperm candle, or more generally in recent years the Harcourt pentane lamp, has been used. It is definitely known now that the candle obtained through the pentane lamp does not bear to the hefner candle the ratio of 1 to 0.88. From comparisons through electric lamps measured at the National Physical Laboratory in England and at the Physikalische-Technische-Reichsanstalt in Germany, the above ratio is found to be in error by two per cent. From direct comparisons of Hefner and Harcourt pentane lamps the ratio appears to be in error by four or five per cent. If now both the gas and electric lighting industries adopt the same unit, which could be maintained at a national laboratory, and in terms of which working standards for both gas and electric lamps could be calibrated, "candle power" would have a single significance throughout the entire country.

The final step would be to agree with other civilized countries on the value of the unit adopted so that we might have in photometry, as in most other branches of physical science, an international unit. Although the German unit is so different from the others as to offer considerable difficulty to the realization of this plan, the units of England, France and the United States are sufficiently close to warrant a compromise. This compromise would not entail the abolishment of the present standards; it would merely necessitate assigning to the standards different numerical values. Thus the Carcel would no longer be 9.6 bougies decimales, but 9.5 or 9.4 international candles. Each country could maintain the unit through whatever standards it chose, primary or secondary, but by frequent intercomparisons among the various countries, the unit would be maintained. Let the search for a suitable primary standard be

continued, and may the time soon come when there shall not only be an international unit, but an international standard which shall take rank with the other international standards of modern physical science.

A Graphic Illuminating Chart

By Albert F. Parks.

The writer takes pleasure in presenting a form of graphical calculator designed to solve with facility foot-candle problems, with the desire that its use may remove much of the drudgery attendant upon this class of determinations, and by its ease of application render unnecessary much of the guesswork now but too evident in many existing lighting installations.

The information to be derived from the chart now exists in tabular form, it is true, but the former presents to view the whole story at one time, thus showing limitations and results that require in the latter form more or less numerous trial calculations, or the carrying from page to page, of certain facts and figures.

A further advantage believed to rather enlarge the field of usefulness of the calculator, is the facility with which terminal or intermediate quantities may be selected and the remaining quantities rapidly determined. While the range of the chart, as shown, may not satisfy the requirements for certain classes of work, its limits may be expanded or contracted by a simple mental calculation, as multiplying or dividing the candle-power scale by ten, the foot-candle scale will be affected likewise. If this be considered undesirable, however, any one but slightly acquainted with logarithmic functions and scales can easily lay down a chart to please his individual fancy.

A description of the method for constructing the chart may possibly save the digging up of forgotten lore on the part of some busy brother, so is here roughly outlined.

The equation upon which the chart is based is the well-known one.

$$I = \frac{C}{H^2} \cos^3 a$$

Where

I = Illumination in foot-candles normal to the plane to be illuminated.

C = Candle-power reading from a photometric curve.

A = Angle made by reading C with normal to plane illuminated.

H = Minimum distance source of illumination to this plane.

Solving this equation by logarithms consists, as is well known, of finding log of C, log. of $\cos^3 a$, adding same together and substracting log. of H^2, the remainder giving the logarithm of the result desired, this being exactly the graphic method followed in working the chart.

In Fig. I if the distance A—B be laid off representing log. C, and A—C a distance representing log. $\cos^3 a$, completing the rectangle will give point D, it is desired to add the length of A—C to the length A—B, however, and fortunately we may do this graphically if from D we draw a line D—E at an angle of 45° till it cuts the line A—B produced. A—E now represents log. C + log. $\cos^3 a$. We now wish to subtract from A—E a distance equal to log. H^2.

Laying off vertically from E such a distance E—F, we may by means of a 45° line through F, subtract from A—E this distance E—F, giving us the point G, A—G then representing the solution of the problem or A—G = log. C + log. $\cos^3 a$ — log. H^2. If now the diagonal G—F be properly labeled, all values of E—F falling on this line will have the same foot-candle readings, and for each other foot-candle reading there will be a diagonal parallel to F—G.

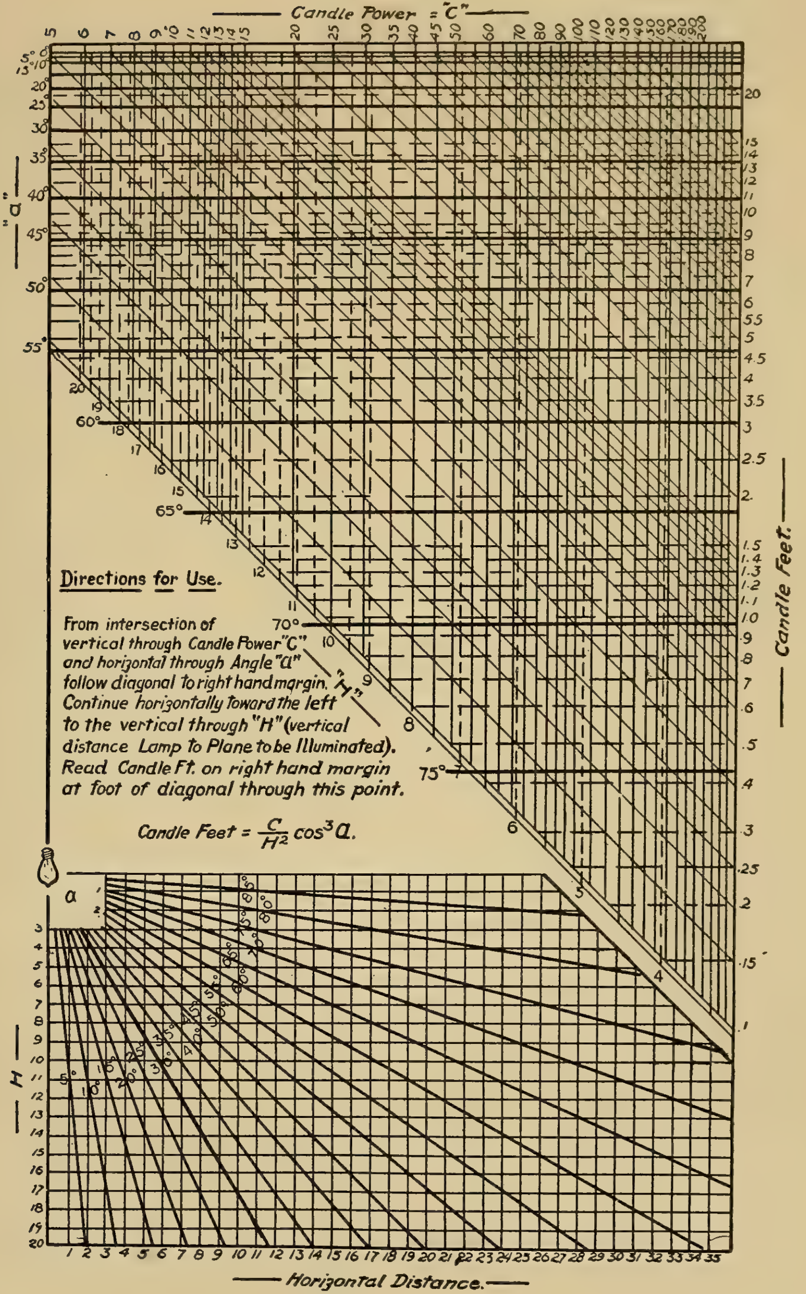
While a chart, constructed exactly as per the foregoing description, may be conveniently used, the form here presented is somewhat different in arrangement, for by a proper manipulation of axes, one set of diagonals may be made to do duty for both D—E and F—G functions, and considerable saving in space and complexity results.

A few samples may perhaps further elucidate the working of the chart.

Say that from a photometric curve we get 50 C. P. in a vertical direction, and 100 C. P. an angle of 45°. It is desired to find the illumination on a plane at six feet below the source of light.

Taking first the 50 C. P. reading. As A in this case is O, we find 50 on the top C. P. scale, and follow the diagonal lines to the right hand margin, giving the point 5. We now follow horizontally toward the left to the vertical through the point 6 found on the lower inclined margin. Following a diagonal again to the right hand margin we find for the value required 1.40 foot-candles.

Again from 100 C. P. on the top scale we follow vertically to the horizontal line


Candle Power = "C"
"a"
Candle Feet.
H
Horizontal Distance.
Directions for Use.
From intersection of vertical through Candle Power "C" and horizontal through Angle "a" follow diagonal to right hand margin. Continue horizontally toward the left to the vertical through "H" (vertical distance Lamp to Plane to be Illuminated). Read Candle Ft. on right hand margin at foot of diagonal through this point.
Candle Feet = $\frac{C}{H^2} \cos^3 a$.

through 45° found on left hand margin, from this intersection follow diagonal to right hand margin to 3.5.

Proceed toward the left horizontally to vertical through 6 as before, and again along a diagonal from this intersection to the right hand margin, giving 1 foot-candle as the desired result.

As an example of the reversibility of the chart, the following problem will be solved. Let it be required to construct a photometric curve that will produce a uniform illumination of 1.5 foot-candles upon a plane seven feet below the light source. Find the intersection of the diagonal from 1.5 on right hand margin with vertical through 7 on lower scale.

Follow horizontally to the right, to right hand margin continue from this point along a diagonal toward the top, and where this diagonal cuts the several degree lines, will be found the C. P. readings required at these angles. As 205 C.P. at 45°, 165 C.P. at 40°, 132 C.P. at 35°, 110 C.P. at 30°, 96 C.P. at 25, etc., etc., to 72 C.P. at zero degrees.

Other applications will suggest themselves as one becomes familiar with the working of the calculation.

The angle diagram at the bottom of the sheet is in no way involved in the working of the chart, as described, but has been added as a matter of convenience only.

The writer regrets that the chart was completed before becoming aware that the term foot-candle had been officially adopted by the Society, also that haste in the preparation of the calculator is responsible for some slight inaccuracies of construction.

It is, therefore, desired that the accompanying diagram be considered more as a suggested form for convenient use than an actual working chart.

With the hope that the above hastily prepared explanation may enable any one interested to construct and successfully use the device and that the usefulness of the chart may justify encroaching upon the valuable time of the convention, this communication is respectfully submitted to its consideration.

New York, July 15, 1907.

The Present Status of Candle-Power Standards for Gas

By C. H. Stone.

In considering a subject of such breadth and importance as the above, it will be readily granted that no casual statement of facts and conditions will suffice, but that a careful survey of the causes which have led up to such conditions is absolutely essential to a clear comprehension of the matter. I trust, therefore, that I may be pardoned for referring very briefly, at different stages of this paper, to certain facts and experiences in the history of gas lighting which have an important bearing on the question before us.

In the development of the gas industry, the question of candle power may be said to have passed through three periods: the first extending from the introduction of gas up to the time when the electrical business became a serious competitor; the second continuing on to the introduction of the Welsbach mantle, and the third from the latter date up to the present time. During the first period the candle powers gradually rose as the methods of production became perfected, until they reached a very satisfactory figure. In the second epoch there was a frenzied effort so to increase the illuminating power of gas that it might successfully hold its own against its new rival; while since the Welsbach has come into general use there has been a strong tendency to reduce the candle power requirements, provided that the calorific value of the gas did not materially decrease. By this I do not wish to be understood as saying that the Welsbach has been the sole cause of this change; at least two other factors have been very potent, namely, the increase in price and the decrease in quality of oil, and the demand for cheaper gas. It is a well-known fact that naphtha of very excellent quality could be purchased a few years ago for two cents a gallon, while to-day this same oil costs three or four times that amount and is difficult to procure even then. Cannel coal will soon be but a memory of the past, and the general testimony of gas men is that the quality of gas coal itself has vastly deteriorated of late years; while, as if to aggravate the situation, hard-hearted politicians are continually ordering reductions in the price of gas. These changes in standards have, therefore, doubtless been advisable and even necessary; yet we must recognize and remember the fact that they have played an important part in shaping public opinion.

In our consideration of the proper standards for gas at the present time, I should like to lay down two principles at the start, both of which seem to me to be axiomatic: first, the consumer is entitled to receive a

constant supply of gas of a satisfactory quality and at a reasonable price; second, the gas company is entitled to fair treatment and a reasonable return from its investment. Now I am aware that by these seemingly innocent and just statements I have put myself in opposition to the opinions of a large number of worthy citizens who believe that all gas companies are robbers and should be treated as such; that the gas which they furnish is never good and that they charge at least 100 per cent. too much for it. This may sound like gross exaggeration to the uninitiated, but I think every gas man has, like myself, had similar statements made to him. I am also aware that there is a vast movement throughout this country, tending to reduce the profits of public utility corporations and at the same time to compel the latter to increase the efficiency of their service. I am heartily in favor of this movement, provided that it proceeds only far enough to remedy existing evils and to prevent the growth of fresh ones; but I believe that the majority of thinking men in the United States are coming to see that they can strike no more fatal blow at their own interests than by reducing the profits of legitimate enterprises to such a degree that not only will there be difficulty in securing needed investments of fresh capital, but also that the efficiency of the service rendered will of necessity be decreased.

Now I presume we are all agreed that the days of high candle powers are over; that the companies cannot afford to make, nor the consumers to use, unenriched coal gas of twenty candle power, such as I have seen once or twice in New York State within the past six months; and the question, from the consumer's point of view, simmers down to this: What is a satisfactory candle power? When London was first generally lighted by gas in 1816, doubtless the change from the oil lamp was so great that a very general satisfaction was experienced. When the electric light became a competitor for public favor and the candle powers of gas were pushed up to 30 and 32, the public was certainly receiving all the light which it could reasonably expect. In this connection, and as an illustration of what some people expect, I might say that at the time when 32 candle gas was being supplied in New York city, one eminent citizen informed a friend of mine that he was getting the meanest gas supplied by any company on earth. Now when, with the introduction of the Welsbach, the companies reduced their candle power, a feeling naturally arose in the minds of the consumers that they were being defrauded; and I want to urge upon your attention the fact that public opinion is a most powerful factor, which must be taken into account by any legislature or commission which endeavors to fix a standard for candle power. This is an element which our English brethren forget, or do not understand, when they criticize the standards established in this country. Conditions and people are very different here from what they are in England. We are a people living at the highest tension; we work strenuously and demand the same strenuousness and high efficiency in all our servants, be they animate or inanimate. Moreover, the will of our people is coming more and more to be, as it should, the dominant factor in political life; and I ask you, gentlemen, remembering as you must that the cry in every branch of our industries is for higher efficiency—better steel rails, purer foods, stronger and better equipped cars, more carefully prepared chemicals, etc.—I ask you in all frankness what you think would happen if a commission should direct that a company which had been supplying eighteen candle gas need only make it of fourteen candle power in the future? I do not refer to the fate of the commission for, most assuredly, that does not enter into the question; but do you think that such a ruling would be allowed to stand very long? There is undoubtedly a point beyond which an increase of candle power means an increase in cost without any proportionate gain to the consumer, but I do not believe that the exact location of that point has been accurately determined, and until it is we must go slowly. Remember, too, that until very recent years the gas business was a dark and bloody mystery to the vast majority of people; and I honestly believe that the secrecy and high-handedness (to use no harsher terms), which marked the early stages of the industry, are largely responsible for the present antagonistic attitude of the people toward the companies. This is being gradually overcome by the policy of frankness and considerateness that is in vogue with most managers of gas plants today, and the time will undoubtedly come when none but scientific considerations need influence the study of standards for gas. It will, however, take time to obliterate the mistakes of the past, and to educate the people up to the point where they will understand that a gas company is conducted

on sound business principles and is worthy of the esteem and confidence which are shown other public utilities.

To turn to the relation of the Welsbach light to candle power, I believe the most important reason which is urged in support of a reduction in candle power is that the greater part of the gas used to-day is burned in Welsbachs and stoves. Eliminating the stoves, which in no way affect the problem before us, it is a question as to what proportion of the gas used exclusively for lighting is burned in Welsbachs, and there is no exact information on this subject to guide us. Here again English standards cannot be literally applied in this country, since it is, so far as I know, an indisputable fact that the Welsbach is in much more general use in England than in the United States. I recently made a tour of all sections of Brooklyn, and took considerable pains to notice the proportion of Welsbach burners in use, and found it much less than I had anticipated or than is generally stated. I have noted the same thing in other cities and towns throughout New York State, and especially in the hotels where a large amount of gas is burned. Now it is only to protect those consumers who are using common burners that a candle power standard is of any value at all; and it is therefore obvious that the mere fact of most of the gas is being used in Welsbachs has no bearing on the question of what light that gas will give or ought to give in an open burner. A candle power standard neither helps nor defrauds the person using only Welsbachs; if you desire to set a standard to protect such people it must be one of heating value. It should also be remembered that while the candle power as determined in a photometer is found with the burner best suited to the gas, the consumer as a rule does not employ such a burner, and this may make a difference of from four to six candles in the light which he receives. Thus a coal gas recently tested in New York gave thirteen candle power with an Argand burner and only seven with a burner commonly used by the people of that town. There is an admitted difference between the old standard English Argand and the new Metropolitan Argand of about two candle power in favor of the latter; so that a gas which gave fifteen candle power with the Metropolitan might very well show only eight with a common lava tip burner, and I think everyone will admit that such a light is insufficient and unsatisfactory. I believe that gas should be tested, as is the law in Massachusetts, with the burner best adapted to it, which is at the same time practicable for domestic use; and while the cost of the Metropolitan burner continues to be $46, it would hardly seem to come under the last clause of this requirement. If we are to test gas for candle power at all, it must be with the object of seeing that those using ordinary burners secure adequate light therefrom; and if we assume that twelve candle power through such burners is not excessive, then the standard must not be below sixteen if the gas is tested with the most favorable burner. The query then naturally arises, if sixteen be a satisfactory standard, why should the figure be set at twenty for water gas? In answer to this, I would cite first the second axiom which I proposed: The gas company is entitled to fair treatment and to a fair return on its investment. To make a coal gas of sixteen candle power the year round, necessitates enrichment and additional expense, while a water gas of that luminosity can be made for less money than is expended on many of the water gases of today. If the standard therefore be set at sixteen for all kinds of gas, there is unjust discrimination against the coal gas plants. It seems to be as easy to make a water gas of twenty candle power as it is to make a coal gas of sixteen, and if the operations are well conducted, the heat units in each will be approximately the same. Moreover, the very able committee which submitted recommendations to the New York Commission on Gas and Electricity as to their idea of the proper standards to be fixed, placed an interval of four candle power between water and coal gas and I am sure that most of us will willingly accept their judgment on this point. There is another reason for a higher standard for water gas which is not generally accepted by gas men. This is, to coin an expression, that the intrinsic satisfaction of coal gas seems to be above that of water gas. This may be hard to understand and harder to explain, but, in common with many others, I believe it to be a fact. It is said that a candle power is a candle power, whether from water or coal gas, and that is undoubtedly true; but it does not bear at all upon the statement above made. It is not claimed that a sixteen candle power coal gas gives any more light than a water gas of the same candle power, but that the satisfaction experienced by the person using these lights is greater in the

case of the coal gas. Whether this is due to the different color of the flame, to the preponderance of one kind of rays in coal gas and of another in water gas, to a difference in flame area or to some other cause, I am unable to say and the assertion is simply made as the opinion of many who have considered the subject. R. M. Searle, of Rochester, in the hearing before the New York Commission, stated that the reason why water gas should be made of higher candle power than coal gas was that the former was liable to carry unfixed illuminants, and if these were dropped the lighting value of the gas might fall two or three candles. This is undoubtedly true, but is, to my mind, apart from the question at issue, since whatever the standard set the manufacturer must make due allowance for this.

I think that now I have shown at least a few of the reasons why the consumer thinks he should get gas of sixteen, eighteen or twenty candle power, and we come, therefore, to the second and no less important division of our theme: Can the companies make gas of this quality, make it the year round and still have a reasonable profit from their operations? With regard to water gas, I believe the answer is fairly simple. Given a good plant and a competent manager, and I think there will be no doubt that twenty candle power will be reached the year round. Of course, there may be days when accidents will occur and the candle power may drop to nineteen or even eighteen; but if we were to set a standard to cover such cases it would have to be less than seven candle power, for twice in the State of New York I have seen a coal gas of less than eight, and once a water gas of under nine candle power. Due allowance should, of course, be made for unavoidable accidents, but I think you will see from the above illustration how impossible it would be to set a standard below which no company would ever fall. For some time now the minimum candle power for the city of New York has been 22, and I understand that the companies have rarely fallen below it, although it has doubtless been a great strain to accomplish this feat. In the District of Columbia, the standard is also 22, and in looking over the Inspector's report for 1906 I note that, although neither of the companies tested makes a straight water gas, the candle power was very seldom below 20, and a majority of the times when it was deficient occurred during the reconstruction of the Georgetown plant. In Massachusetts, during my service there as assistant inspector, I remember but one company which made water gas of under twenty candle power, and that as a rule, the inspector was declared to be wrong if he reported less than 21. At Troy, N. Y., where there is a good plant and a most capable manager, I doubt if the candle power ever drops below twenty, and the same is true of Albany. From these instances it will be seen that it is possible to make twenty candle water gas; and while I am unable to give definite figures as to cost of production, I think no one will readily believe that companies such as those at Albany, Troy and New York are running at a loss. It may be urged that all the examples cited are those of large, well-equipped plants. So they are, and the same facts do not hold true for some of the smaller companies which are running with worn-out or antiquated apparatus. But it is an open question whether the public should receive poor service because of the neglect or greed of managers and owners of the past. If we apply the same rules to these companies as we do to railroad corporations or private concerns, they must either keep abreast of the times or be driven to the wall. It is a hard law, this survival of the fittest, but it seems to apply in every department of life.

With the coal gas companies, the case is a little different. I admit at the outset that it is impossible to-day to make unenriched coal gas that shall be above sixteen candle power the year round. The problem then is: Can a coal gas company enrich its product for a part of the year and still secure a fair return on its investment? At the hearing before the New York commission referred to above, a leading expert stated that it was utterly impossible to secure cannel coal for this purpose. My inquiries among the New York companies do not completely bear out this statement, for I find several that have no difficulty in securing cannel regularly and at a fair price; but for the sake of argument let us assume that the only enrichers available are benzol and water gas. If a water gas plant is already installed, there can be no question as to the possibility of enriching at a small cost; if one is not installed, the interest on the proposed investment must also be considered. A Lowe water gas set, with the necessary buildings, will cost about $7,000; the interest on this at 5 per cent. is $350 a year. For a plant selling 10,000,000 cubic feet of gas a year, this means an added cost of 3½ cents per 1,000

cubic feet, and the actual cost of enrichment added to this will leave the total well under six cents. I think this figure is not prohibitive, and indeed in places where only 10,000,000 feet of gas are used in a year the price is generally high enough to cover easily this extra cost. In the plants that are too small to afford even this, resort must be had to benzol enrichment. This is a much less satisfactory method because of the tendency of gas thus enriched to drop its illuminants; but on the other hand it requires but slight initial outlay and is well adapted to small works. I know of a benzol enriching plant which is being installed in a New York company, the total cost of which is not to exceed $200, and the manager assured me that by its use he was confident that he could keep his gas up to eighteen candle power. This certainly would seem to place this method within the reach of all companies. Moreover, it is generally true that such small companies get a much greater price for their gas, and this in a measure compensates for the additional burden placed on them, as one of the managers admitted in the hearing before the New York commission.

Now it has been urged that as soon as a coal gas was enriched by oil or water gas it ceased to be a coal gas and became a mixed gas. This is theoretically true, but I am certain that inspecting authorities would not as a rule so consider it, provided the oil or water gas was added simply for enriching purposes. Water gas is really a mixture of water and oil gases, but it is not considered as a mixed gas, and similarly I think a mixture of coal and oil gases would be considered a simple gas. As to mixtures of coal and water gas, this point is hinted at in the bill recently passed by the New York Legislature entitled, "An act fixing standards of purity, illuminating power and pressure of gas in cities of the second class." This provides that if the gas to be tested contains over 50 per cent. of coal gas, the candle power shall be determined with an F Argand burner; but if it carries 50 per cent. or less of coal gas a No. 7 slit union Bray burner shall be used. A regulation could and should be drafted which would fix the line of demarkation between coal gas enriched with water gas, and a mixed gas; if this is not done, coal gas companies will cease to exist and there will be no need of a sixteen candle standard.

It may be of value at this time to look for a moment at places where standards have been established in this country and see if the companies have been able to live up to them. The experts recently employed by the city of Detroit to suggest regulations for that city recommended that the candle power should not be less than 18 on three occasions within 30 days. In the District of Columbia, by Act of June 23, 1874, the minimum candle power permitted is 22, and the two companies in that District averaged, in 1906, 12, 22 and 23.05 respectively, and the company with the latter average supplies a coal gas enriched with oil or naphtha. In the report of the Department of Inland Revenue, Ottawa, Can., for the year ending June 30, 1905, it states that the gas in that territory, where the standard is sixteen, was below the limit twice in one town and three times in one other, out of a total of 881 tests made. In Massachusetts, which has probably given more study to the gas question than any state in the Union and whose methods of procedure are often cited as models, the first law on inspection of gas was passed in 1861 and ordered that gas should not be merchantable which was of less than twelve candle power. About 1880 this standard was raised to fifteen, and Maj. C. W. Hinman, the state inspector at that time, says in his report for 1885: "At no time during the past year has any gas been found as low as fifteen candle power and only ten tests were below sixteen." In January, 1888, he says, "I am of the opinion that the standard should be sixteen candle power." As justification of this it might be well to state that in seven preceding years there had been only eight companies found below sixteen candle power, and most of these by only a few tenths of a candle. In February, 1892, he reported his recommendation that the standard be raised, and on March 14, 1892, his suggestion was adopted by the legislature. During that year two companies were found below the new standard, 0.1 and 0.3 of a candle power; in 1893 four companies were deficient, once each; in 1904, 1905 and 1906 three companies were under the mark in each of these years, and the same general condition continued until 1902, when 23 companies were deficient; in 1903, 37 companies; in 1904, 35; in 1905, 19, and in 1906, 22 companies. In these latter years, however, it is to be noted that a large proportion of the deficiencies were also under fifteen candle power so that the latter as a legal minimum would not have made much difference. In New York City the standard of 22 candle power has been nobly observed, although with considerable difficulty. The act of the

New York Legislature before referred to sets the standard for cities of the second class at sixteen candle power for coal, eighteen for mixed and twenty for water gas. In Buffalo, where a coal gas is supplied and water gas prohibited, the standard has been eighteen, and the company has rarely fallen below this figure. Auburn is obliged to furnish eighteen candle gas, and the same is true of Syracuse and Plattsburg. Mr. Searle, of Rochester, voluntarily offered to supply mixed gas of twenty candle power, and he certainly is capable of judging the possibilities of his plant. Thus it will be seen that the figures of sixteen, eighteen and twenty which I have endeavored to defend are as low as any of the North American continent, and that in most cases where these or higher standards have existed, it has been within the powers of the various companies to comply with them.

In closing, may I be permitted to emphasize one or two important points? First, the frame of mind of the American people to-day will not allow of any reduction in standards. Second, candle power requirements are made purely to protect those consumers who use gas in open burners, and the fact that the greater part of the gas sold for lighting is used in Welsbachs does not enter into the question at all, since the candle power has no known relation to the heat units. I will admit that the most desirable thing to do, in my opinion, is to abolish candle power standards entirely, set a standard for heat units and thus ascertain the suitability of the gas in its most essential feature. By so doing you would protect the majority of consumers and would be certain that the greater part of the gas burned was suitable for the work required of it. I believe that the time will come when the calorific value of gas will be the only vital point to be considered in connection with its quality; but at present there are two vast obstacles to such a course of procedure. In the first place, the testimony of some of the best experts in the country is unanimous that no standard of calorific value could be set which would always be reached by the companies. Mr. Searle, in his evidence before the New York commission, said: "I am absolutely frank to say I do not think it is possible for any company to maintain a fixed calorific value. It is absolutely beyond human scope." In answer to a question as to whether he would ever make gas of less than 410 British thermal units, he replied: "I don't know." At the same hearing Dr. A. H. Elliott, of New York, expressed himself as opposed to any heat unit standard, and many others could be quoted whose opinions coincide with this. The second obstacle is the fact that there is to-day no satisfactory portable calorimeter which can be put in the hands of an ordinary assistant and furnish accurate results. There are some excellent ones on the market, but they fail in one or the other of these requirements. I have found this true in my own experience, and it has been abundantly confirmed by such men as Dr. Elliott, Mr. Searle, Mr. Jenkins, the state gas inspector of Massachusetts, and many others. Until these two difficulties can be overcome, any question of a calorific test, to be made over an entire state, must be relegated to the future.

Next, I believe that a standard of sixteen candle-power for coal gas has been and can be maintained, but only—and please note carefully this qualifying clause—only by enrichment; and that the majority of water gas companies will have no difficulty in making twenty candle gas the year round. I feel that the expense involved in living up to these standards is not prohibitive, and that, if they are to be of any benefit to the consumers using open burners, they cannot be set at lower figures than the above. Moreover, the companies will themselves reap benefits from this course of procedure. In very many cases in New York State, the gas men have a hard struggle to compete with the electric companies; and can you wonder when one water gas company has furnished gas of less than nine candle-power; when a large number of the tests show dirty gas; when there are twelve coal gas works in the State which, according to the average of the tests thus far made, furnish gas of under fourteen candles; when sixteen tests out of a total of 102 found the coal gas under eleven candles, and when only sixteen out of the forty-one coal gas companies are above fifteen candle-power. I reiterate that a law demanding increased efficiency will, if not carried too far, benefit such companies as those just cited. Lastly, I am certain that the time is coming, and is now near, when the question of candle-power tests will be but a bitter recollection of the past, and when the one great question will be as to calorific value.

PROCEEDINGS

Papers Read Before Technical Societies

DISCUSSION

Photometry of Different Colored Lights

By M. Lauriol.

[*Paper Presented to the International Photometric Committee.*]
(Translated by *The Journal of Gas Lighting.*)

I.—Briefly, it will be taken for granted in the sequel that (1) the absorptive power of the air can be neglected, and (2) the dimensions of the sources or groups of sources of light are infinitely small in comparison with the distance from the objects illuminated. As most sources have different illuminating intensities in different directions, when the intensity of a source or the effect produced by it is spoken of, it will be understood that these expressions apply to a particular direction.

II.—Experience furnishes us with a first general law—viz., a source A, acting at a distance a, produces the same effect as a group of n^2 similar sources acting at the distance na.

When a source A is compared with a standard of the same color E, the intensity of A measured relatively to E is by the definition the ratio $\frac{e}{a}$, which results from the condition that a group of sources e similar to E produces under all circumstances the same effect as a group of sources a similar to A. The law set out at the beginning of this paragraph admits of another definition of intensity being given—viz., it is the ratio $\frac{u^2}{v^2}$ which results from the conditions that the source A acting at the distance u produces the same effects as the source E acting at the distance v.

III.—The intensity so defined has, in monochromatic photometry, a perfectly clear meaning, and is indeed an inherent property of the source under consideration. The figure found is independent of the mode of measurement, and of all the circumstances of that measurement, of the nature of the effect which one endeavors to balance, of the absolute values of the numbers a and e on the one hand, and u and v on the other hand, etc. All the modes will theoretically be equally good; and choice will be guided simply by considerations of convenience or of exactness. The intensity of a group of sources is equal to the sum of the individual intensities of each source. The relation between the intensities of the two sources is independent of the common unit by which they are measured. To sum up, it is justifiable to state that the intensity so defined gives an exact measure of the value of the source.

IV.—When two sources of different colors are compared, the conditions are changed. The effects produced by two sources will not always be the same; but in certain cases it will be possible merely to judge that they are equivalent. This judgment carries a greater uncertainty the greater the difference between the two colors. Further systematic differences are introduced, depending on all the conditions of measurements. A source of light no longer has a certain intensity, but an infinity of intensities according to the mode followed, and with the same mode according to various numerical experimental data. The principal causes of variation will be enumerated later. Then there is the radical and absolute impossibility of saying that a source A is twice or three times the value of another source B. All that can be said is that in a first case, a second case, or a third case the source A had a value twice, or two-and-a-half times, or thrice the value of B. Which figure is to be chosen to represent the value of the source A?

Various definitions of the intensity of lights have been selected from among the many available. For instance, (1) the relative intensity of the sources after filtration through a monochromatic screen which allows only certain radiation at the limit of the yellow or the green to pass; (2) the limit towards which the relative intensity approaches when the illuminations approach zero; (3) the integral of impressions obtained on a photographic plate by making each radiation act in succession for a given time, which is a function of the wavelength. None of these definitions is *per se* good or bad. Do they correspond with the average conditions in practice? That is the only question. To accept or reject one or the other, comparison must be made with the average conditions in practice.

V.—At the outset, we may somewhat ingenuously recall the fact that the sources of light enable us to see the illuminated objects. To keep to the general practical case, we ought only to depend on phenomena of light, sensible to our eyes, and consequently to photometers properly so called, and so to exclude apparatus such as the selenium pile, bolometers, or photographic plates. The figures thus obtained will evidently have no particular value for a medical man, who looks for certain physiological actions by a focus of light, or for a photographer, who looks for certain chemical effects, etc. But it is necessary to keep within limits.

VI.—Various physicians and physiologists—among others M. Andre Broca—have shown the influence which fatigue of the eye, more or less severe, and the duration of the impression of the light, cause on measurements. In an analogous train of ideas, the author has found variations of 20 per cent. in the relative intensity of a Nernst lamp and an ordinary electric glow lamp, according as it was measured with the Simmance-Abady flicker photometer as normally worked with the disc rotating, or with the same photometer with the disc at rest so that the equality of illumination was judged on the two juxtaposed surfaces at rest. Practically the objects, whether fixed or moving slowly, which are being observed, retain constant illumination for an infinite period (*i.e.*, a second or more); they are observed with an eye which has received the impression of the surrounding light for an infinite period (a second or more), and is fatigued to an extreme extent. We shall have to work under these conditions, which are those obtaining in all photometers with fixed surfaces, to the exclusion of flicker photometers.

VII.—The apparent diameter of the surfaces of observation appears to have an influence, which is still imperfectly known, on the results of the measurements. It would appear that, according as this diameter varies, the image reaches or fails to reach various parts of the retina of varying susceptibility to impressions. Practically illumination is of most value to us in the direction determined by the eye, or in its vicinity. Consequently, tests should be made to ascertain a maximum limit for the diameter viewed, below which we ought always to stop.

VIII.—Objects of every color have to be observed set on backgrounds of every color; and in this lies the possibility of the relative values of two sources varying to a very great extent. A weak source of green light will be superior to a powerful source of red light, if green objects have to be distinguished on a black ground or red objects on a white ground, or *vice versa*. A single measurement of the relative intensity of the two sources will therefore give a figure differing very greatly from their true relative value under different conditions. The least objectionable solution in such a case will be to compare the illumination of two white surfaces, just as is done in the majority of photometers.

IX.—The intensity found varies with the absolute illumination. This is one of the facts which have been investigated longest. For instance, the intensity of a Nernst lamp, measured relatively to that of an ordinary electric glow lamp, has been found to vary between the ratios of 100 to 80 and 100. In this instance, the absolute illumination varies within less wide limits than those between which it varies in practice. In this special case, it is noticeable that the variation is not in a constant sense. It is scarcely possible to choose an average condition. There are variations from 1000 *lux* to 0.1 *lux* between the maximum illumination of a work-table and the minimum illumination of a public street. In general, the sources ought to be tested over these limits; but it is between 50 *lux* and 0.5 *lux* that the measurements are specially of interest.

X.—The intensity found varies as a function of the absolute illumination, but of the absolute illumination of what? Clearly it can only be as a function of the illumination of the images on the retina. Therefore every cause which produces variation of the illumination of the images on the re-

tina, while the illumination of the photometric screen remains constant, will produce a variation in the figure found for the relative intensity of two sources. If, when making an observation, we wink, or obscure the pupil of the eye, we cause the illumination on the retina to vary, and we observe variations of the apparent relative intensity. This fact has been pointed out by M. Laporte. It will be seen that only one thing can be done in this connection—viz., to keep the eye naturally open when making an observation, and to compare the results obtained by different observers.

With identical illumination of the photometric screen, the illumination on the retina varies with the photometer used, according to the reflections, refractions, diffusions, and absorptions inherent to each instrument. Also, it will be found that, for the same distance between one of the sources and the photometer, the apparent intensity varies with the photometer used. We ought therefore to select a photometer which reduces to a minimum all these modifications of the light, and which shows us the screens as nearly as may be like we see objects in general practice. Generally we observe matt opaque surfaces at all possible angles of incidence. As an average, let us assume that the incident ray and the visual ray are perpendicular to one another, and are both at 45° to the vertical. Between the source and the eye, the light undergoes no other modification than diffusion at the surface of these objects. It ought to be the same with our photometer. Therefore the author suggests the following method with which some observations have been begun. On a rectilinear horizontal bench are mounted the sources of light S^1 and S^2, and the photometer P,

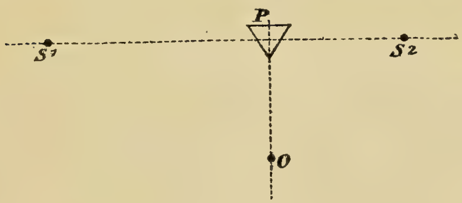


FIG. I.

Fig. 1. The latter consists of an isosceles rectangular prism, with vertical edges. The plane bisecting the angle ought to be perpendicular to the direction of the bench. The eye is put at O in the bisecting plane, at the same height as the photometer and the sources of light. The prism is made of plaster, unglazed porcelain, or any other white matt material. The edge of the facing angle ought to be as sharp as possible. Equality, or at least equivalence of the illumination of the two lateral faces of the prism, is obtained by moving either the photometric prism or the sources of light.

Such a photometer affords a less precise observation than others—such as the Lummer-Brodhun; but it comes nearer to the average conditions of practice, and avoids systematic errors. There is greater reason still for discarding photometers in which the light traverses a translucent screen, like Foucault's photometer, and more particularly the grease-spot photometer, as the phenomena differ too much from the ordinary conditions of practice.

XI.—The intensities being thus measured, the following law (which the author brings forward with all reserve, as it has not yet been sufficiently verified) appears deducible from the tests: *Two illuminations which are equal to a third are equal to one another.* Suppose that the two following results had been found:—

The source A at the distance a is balanced by the source C at the distance c.

The source B at the distance b is balanced by the source C at the distance c.

Then the law cited would indicate that—

The source A at the distance a is balanced by the source B at the distance b.

If this law were more completely verified, granting the laws of variations of the relative intensity of two sources A and B, and of two sources A and C, we should be able to deduce from it the law of variation of the relative intensity of the two sources B and C. Thus, from the two data—

A at the distance a is balanced by B at the distance $f\ (a)$;

A at the distance a is balanced by C at the distance $F\ (a)$;

we should deduce that

B at the distance $f\ (a)$ is balanced by C at the distance $F\ (a)$.

Giving a all possible values, we should then have the law of variation of the relative intensities of B and C. Given the law of variation of intensity of a source by reference to a primary standard, and that of this standard by reference to a secondary standard, the law of variation of the intensity of the source in relation to this secondary standard may be deduced.

XII.—When all this is done, there are still troublesome considerations in the way

of conducting the photometry of lights of different colors, which at any rate render it necessary to make very numerous observations in order to get a result having any meaning. The intensity of a group of sources of light is, generally speaking, different from the sum of the individual intensities of the sources. There is notable inequality in the case where each source is placed separately, and later the whole group, at the same distance from the photometric screen.

The law of variation of the intensity of a source, as a function of its distance from the photometric screen, will not remain the same if the standard used for the measurement is altered. If the intensity of the standard is simply modified, without altering its color, a curve can be deduced from the other curve by increasing or diminishing the ordinates in constant proportion. If the color of the standard is modified, measurements such as those indicated in Section XI. will have to be resorted to. Generally, it will be inexact to multiply the ordinates of a curve by the ratio of the intensities of the two standards, as determined by a single observation on any photometer, and with only one distance between one of the standards and the photometric screen. In particular, for comparing the three standards, the Carcel, the Harcourt, and the Hefner, it would be interesting to have a detailed investigation made with various illuminations and various photometers.

XIII.—Though the intensity of the standard is theoretically a matter of indifference, its color is not. As comparison with natural sunlight is desirable, a standard should be chosen which comes as near as possible to the color of sunlight when atmospheric absorption is at a minimum. So judged, the Carcel and the Harcourt standards appear superior to the Hefner. Perhaps a better may be found.

XIV.—In many cases, comparison is between lights of almost the same color; and no comparisons have to be made with other lights of different colors. For instance, in comparisons of Welsbach burners of different makes one with the other, the chief interest lies in ascertaining their value relatively to one another without troubling greatly about their value relatively to a Carcel lamp or an electric arc. Of the variations of intensity of a source of light with change of direction might be studied. In each of these cases, it would be convenient to adopt a special standard of appropriate color, rather than to refer both to the same standard. For instance, special standards would be used for Welsbach mantles, others for hydrocarbon flames, others for incandescent electric carbon lamps, others for lamps with metallic filaments—such as the osmium, tantalum, or tungsten lamps—others for ordinary arc lamps, and others for flame arc lamps. Comparison rests each time only between two sources of the same color; and there will no longer be any reason for limiting oneself to the use of the photometer mentioned in Section X. In order to make the tests carried out in different laboratories comparable, it would be possible, for instance, to start with the general standard mentioned in Section XIII., and to filter the light through various colored screens, either of thick glass of well-defined composition, or of liquids, as in Crova's green screen.

XV.—The various causes of variation of the apparent intensity of two sources will have so much the less effect, and may be so much the more readily neglected, when the colors are but little different, and no very great degree of precision is aimed at. It is important to make long series of measurements on this point principally with colors much whitened, as is the case with the most general sources of light. The collaboration of numerous laboratories would be useful to this end.

XVI.—To sum up, the author submits this program: Try the photometer described in Section X. Investigate the discrepancies due to difference of eyesight. Investigate the effect of the apparent diameter of the screens, and, if it seems desirable, of a maximum diameter (Section VII.). Compare the Carcel, Harcourt, and Hefner standards with the photometer described in Section X., and investigate the variations of relative intensity as a function of the absolute illumination and of the various photometers employed. Verify the law of illumination referred to in Section XI. Choose a primary standard having, as nearly as may be, the color of solar light (Section XIII.). Choose secondary standards having the colors of the various common sources of light (Section XIV.). Make measurements of intensity in the photometry of different colors for illuminations varying from 1000 *lux* to 0.1 *lux*, and in particular for illuminations ranging from 50 *lux* to 0.5 *lux*. Investigate the degree of approximation to accuracy with which it is possible to assign a particular intensity to each of the various common sources of light (Section XV.).

Commercial Engineering of Illumination

New Publications

INCANDESCENT GAS LIGHTING.

Bulletins issued by the Welsbach Company, Gloucester, N. J. The following numbers have been received:

1. "PROCESS OF MAKING INCANDESCENT MANTLES," by M. C. Whitaker, General Superintendent of the Welsbach Company.

2. "PIONEERS IN INCANDESCENT GAS LIGHTING," by M. C. Whitaker; Dr. Waldron Shapleigh, first chief chemist of the Welsbach Company; Dr. Karl auer von Welsbach, inventor of the Welsbach mantle; Prof. Robert Wilhelm Bunsen, inventor of the Bunsen burner.

3. "MONAZITE SAND," by H. S. Miner, chief chemist of the Welsbach Company.

4. "BEADED FRINGE," by A. L. Crawford, Department Purchasing Agent of the Welsbach Company.

5. "AIR-HOLE GLASSWARE," by A. L. Crawford.

6. "DECORATED GLASSWARE," by A. L. Crawford.

7. "MICA AND MICA MINING," by A. P. Storrs, President of the Storrs Mica Company.

8. "INCANDESCENT GAS LAMPS," by T. J. Litle, Jr., Illuminating Engineer of the Welsbach Company. (Read before the Illuminating Engineering Society, Philadelphia, February 15, 1907.)

"INDOOR GAS ARC LAMP," by T. J. Litle, Jr.

"MANUFACTURING FACILITIES," by E. S. Sanderson, of the Scovill Manufacturing Company. First Paper: The Scovill Plant.

An inspection of the titles and authors given above will show the wide scope and high character that the Welsbach Company have set for their publications. The bulletins are attractively printed and fully illustrated, and, with the exception of the imprint of the Welsbach Company on the title page, are entirely free from any of the familiar advertising ear marks; in fact, they are popular scientific and technical papers by writers whose authority is beyond question, and will form a valuable acquisition to the library of anyone who has even a passing interest in modern science. The Welsbach Company are deserving of both praise and congratulations for the admirable manner in which they have thus far carried out this new departure in their Publicity Department.

"The Holophane System of Illumination." Bulletin No. 1, issued by the Holophane Company, July 1st.

This is strictly a trade bulletin, illustrating a considerable number of the most popular types of Holophane globes and reflectors, giving prices, and such other data as may be of assistance to those contemplating their use.

N. E. L. A. Bulletin, Volume 1, Number 1, August, 1907.

This little publication is an outgrowth of the question-box feature of the Association, and its chief purpose will be to afford a means of interchange of ideas among its members from month to month, rather than from year to year, as has been the custom heretofore. The idea seems a most excellent one, and the bulletin should prove of very considerable value to the members. It exemplifies one form of coöperation, and coöperation seems to be the watchword of the electrical industries at the present time. To coöperate by interchange of experience and knowledge can certainly result only in general good, and all members should feel it a privilege to ask questions without reserve, and a duty to answer whenever their particular experience or information will be of service.

Electrical Coöperator's Creed

FIRST PRIZE.

I believe in Electricity—the greatest "city" on Earth.

Daughter of Science and Mother of Progress.

Sister of Civilization, Handmaid of Industry and First Cousin to the Spirit of Peace on Earth and Good Will to Man.

Lightener of Burdens, Tamer of Wilderness, Annihilator of Distance and Goddess of Light.

The most necessary of luxuries.

The most luxurious of necessities.

Who wouldn't believe in Electricity?

I believe in Co-operation.

Pennant-winning "team-work," rather than individual grand-stand play.

Constructive and profitable combination as opposed to destructive, unprofitable competition.

Greater general progress through reduction of individual friction.

Working together for the Grand Prize, instead of quarreling together over scanty profits.

Co-operation?—who wouldn't be a cooperator?

I believe in Electrical Co-operation.

"All together all the time for everything electrical"—The application of the highest law of Modern Business to the greatest business of Modern Times.

The massing of forces to boost the sale of current and everything under Heaven that uses current—the Generator of an enlightened "current opinion."

The step-up Transformer of low-efficiency selfishness to high-voltage helpfulness—the incandescence of enthusiasm against the resistance of Conservatism—and the short circuit to the final and complete electrification of the Universe and to that millennium age when what isn't done by electricity won't be done at all.

Charles A. Parker.

SECOND PRIZE.

I believe in co-operation.

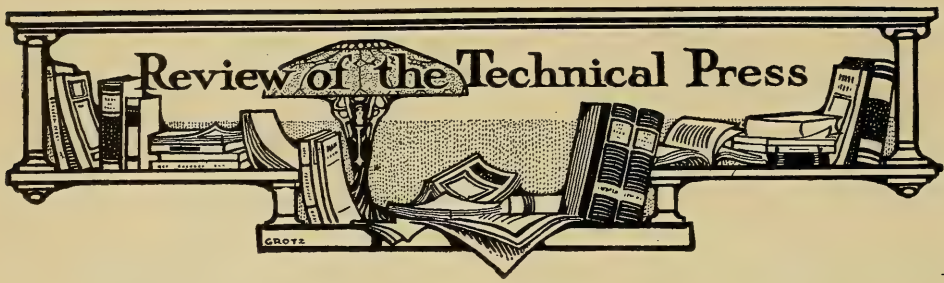
I believe that if one-half the time, labor and money now spent in commercial strife within the electrical trade, were turned to account in combating the natural competitors of the trade as a whole—if but a small amount of the energy now dissipated in fighting for the business that exists, were devoted to the creating of new business—it would redound to the advantage of all.

I believe that this great advantage to all cannot be secured without the sacrifice on my part, of certain small advantages, the burying of certain animosities and perhaps the loss of certain immediate gains; nevertheless, I believe I am sufficiently broad-gauged and far-sighted to forego the lesser advantage for the greater.

I believe that this can be done without the submerging of my individuality or the loss of any material advantages which I will get back many fold, and of petty pride, which I can well afford to be without.

I believe the time for co-operative action is here. I am ready if you are.

Frank B. Rae, Jr.



American Items

ELECTRICAL EQUIPMENT OF THE HALL OF RECORDS IN MANHATTAN BOROUGH, NEW YORK CITY.—*Electrical World.*

In the general description of the installation the arrangement of the lighting outlets and the character of the fixtures is given, with illustrations.

GAS ARC SCIENCE, by "Engineer." *American Gas Light Journal.*

The article describes a number of ingenious devices for utilizing the gas arc for illuminated signs.

LIGHT IN THE COUNTRY HOME, by A. Cressy Morrison. *Light.*

The article is principally a historical sketch of the development of domestic lighting.

STANDARDS AND UNITS OF LIGHT; *Electrical Age.*

The most common standards of light and forms of photometer are briefly described.

STORY OF THE INCANDESCENT LIGHT, by John Ritchie, Jr. *Electrician and Mechanic.*

A popular treatment of the subject, dealing particularly with the recent forms of metallic filament lamps.

ELECTRICAL DISPLAY IN PHILADELPHIA; *Electrical Review.*

A description of the special lighting provided at the Elks Convention, recently held in that city, with illustrations showing some of the more conspicuous features.

THE SIRIUS COLLOID LAMP; *Electrical Review.*

A description of the present status of Dr. Kuzel's form of Tungsten Lamp.

EDITORIALS:

ELECTRIC LIGHTING: ARC LAMPS; by Geo. R. Metcalf. *Western Electrician.*

This is chapter XXIX under the general title of "Elements of Electrical Engineering," which has been running serially. As would be necessary in such a general treatise, the various features of arc lamps are dealt with in a very brief and elementary manner.

BRIGHT STORE LIGHTS, by Engineer, *American Gas Light Journal.*

This article deals chiefly with the use of gas arc lamps for both interior and exterior lighting, and gives some very good suggestions for this type of illumination.

INTERESTING AND UNIQUE GERMAN MERCURY VAPOR LAMPS; by Frank C. Perkins. *Journal of Electricity, Power and Gas.*

All mercury vapor lamps are interesting, but we fail to find any points of striking novelty in the German make described in this article.

High Efficiency Lamps and the Central Station; *Electrical Review.*

Primary and Secondary Standards of Light.—The Function of the Illuminating Engineer; *Electrical World.*

The Ideal Artificial Light; *Journal of Electricity, Power and Gas.*

Foreign Items

Lighting Progress

From the Electrical Engineer.

Addressing the shareholders at their recent annual meeting, the chairman of one of the electricity supply companies in the country remarked that the introduction of metallic-filament lamps had been responsible for a decrease in the company's revenue from lighting. The same remark has been made by other authorities, and it finds expression once again, this time in the report of the Dudley Corporation electricity undertaking. Dudley's electricity supply account for 1907—which, on a total capital expenditure of £81,410 13s. 7d., and an income for the past year of £11,705, shows a gross profit of £5,244, or, after paying interest on mortgage loans and repaying loans, a net profit of £68—is accompanied by a statement by Mr. C. E. Savage, the resident engineer. He points out that the increase in income from private consumers is small, and goes on to say: "This, on the face of it, might be put down to the unpopularity of electricity as an illuminant, but is accounted for in a most extremely marked degree by the advent on to the market of cheap, highly economical incandescent lamps and efficient and reliable arc lamps. Both the first and the latter type of lighting will affect, to some extent, all engineers during the next few years, but we trust that in the meantime, with such a low price per unit, to connect sufficient consumers (all new consumers being advised to put in metallic-filament or other highly economical lamps), and thus make up for the decrease in income from the private consumers which must naturally ensue. In order to obtain consumers at a sufficient rate, as engineers we may find it necessary when laying cables down new streets to put in a five-wire system, with local balancers, to adopt the 460-volt supply in the case of Dudley for the present metallic-filament lamps, houses would be wired to take the half-voltage of the two outers—namely, 230 volts—and then, when metallic-filament lamps were capable of being manufactured at a marketable price for 250 volts, the outer and the second outer, in the case of a five-wire system, on both sides would be made the true outer, thus giving consumers supply to the middle wire by 230 volts. This suggestion in large towns might pay, as I find that wiring houses for metallic-filament lamps, 120 or 100 volts is both inconvenient and unpopular, the present metallic-filament lamp two in series in one holder being too large a unit for private house lighting." It is not surprising that engineers are encouraging the use of the higher efficiency lamps. The effect of their use upon income is a comparatively unimportant factor at the present moment, for with their higher efficiencies, and consequent saving to the consumer, they will be the means of securing additional customers for the central station, and restore their earning capacities, besides enabling economies in production to be made. The Cooper-Hewitt mercury-vapor lamp is also making headway, and the factory inspector for the Midland division says the light is exceedingly good, and enables work to be carried on which formerly was not readily performed during hours of darkness. It is also said to be very economical, the waste due to production of heat being much smaller than in incandescent lamps and arc lights.

Photometer Utilizing the Cosine Law

From Journal of Gas Lighting.

At a recent meeting of the Physical Society, Mr. J. S. Dow described a form of photometer in which the cosine law is utilized. It is therefore unnecessary to move either the photometer or the sources of light. The adjustment of the illumination of the photometrical surfaces is carried out in the photometer itself by the rotation of a Ritchie wedge about the boundary-line between the photometrical surfaces as axis. The ratio of the candle-powers of the two sources of light compared can then be read off on a suitably calibrated scale attached to the photometer. This type of instrument is very convenient; but, according to an abstract of Mr. Dow's communication in the *Chemical News,* attention was drawn to the possibility of "angle errors" and means of avoiding them. The instrument could be used on the "equality of brightness" principle, or, by utilizing an oscillating lens, as a flicker photometer. The results of using these two photometrical methods were, in this case, in very good agreement. Yet this might not have been so if a different portion of the retina had been utilized, especially at low illuminations.

An experiment was shown illustrating the behavior of the "rods" and "cones" as regards flicker. At strong illuminations, when the cones are predominant, the perception of form and color is most acute when the central portion of the retina is utilized; but at low illuminations, when the rods are in action, visual acuteness is best when the outer region of the retina is used. In the same way the perception of flicker was demonstrated to be only most acute over the portion of the retina removed from the center of the eye when a weak illumination is employed. A distinction must be drawn between "rod-flicker" and "cone-flicker."

Some experiments were shown illustrating the detail-revealing powers of red and green light. A green or blue surface loses in luminosity as the image of it fades more and more towards the center of the retina. But apart from the question of luminosity, the red end of the spectrum gives the best definition in the case of distant vision, and the blue end in the case of very close vision. This arises from the want of achromatism of the eye. Two exactly similar patches of red and blue light were thrown upon a screen on which a black and white chess-board pattern had been traced. The black and white squares were then seen to be more sharply defined when illuminated by the red light, in spite of the fact that the illumination due to the blue light was much the brighter of the two. The red end of the spectrum is therefore, in general, the most effectual portion for the illumination of clocks, shop-signs, and objects which must be viewed from a distance.

Mercury Vapor Lamps

From "Electricity and Electrical Engineering."

Another rumor of lamp efficiency on the up-grade! One-sixth of a watt per candle-power, so we read in the current issue of our contemporary, the *Electrical Review*, in a mention of a meeting of the Electro-Technical Association in Berlin. This is the efficiency claimed for a new type of mercury vapor-lamp, in which Dr. Richard Küch uses a short tube of quartz in place of the long glass tube of the ordinary lamp. A benefit in the color of the light is also claimed, the light in the new type being of a yellow-white, in place of the green-blue admixture of the ordinary lamp. The production of light by luminous gases is evidently a subject to which considerable energy in research is being devoted in various quarters.

Incandescant Cas the Lighthouse Service

Those who remember the lively controversy that raged some twenty years ago over lighthouse illuminants, mainly due to the stubborn defence of gas by the late Mr. Wigham, of Dublin, in connection with the South Foreland experiments, may be mildly surprised that so important a subject has not come to the front again in the changed circumstances of the time. The resources of the lighthouse engineer in respect to the choice of illuminants are much more extensive and varied than they were, with one conspicuous exception. The Engineering Association of New South Wales, recently discussing this matter, found that there has been no marked improvement in the application of electricity to lighthouse purposes. The expense of installation and upkeep is still prohibitory of electric light for any but the most salient headlands, while the exigencies of reliability and fixity of focus present as great difficulties as ever to lamp constructors. In expert judgment it is questionable whether any further additions will be made to electrically illuminated lighthouses, on account of the great development of incandescent gas light, the petroleum vapor burner being at present the prime favorite with lighthouse authorities. The Trintiy House engineers claim to have obtained 1,200 candle-power for a consumption of a pint of oil per hour. The incidental advantages are precision of focusing and penetrating power. Consequently the incandescent mantle, actuated by petroleum vapor, is regarded as the light of the future for lighthouse use at home and abroad. It is beginning to be doubted whether there is much real advantage in the enormously powerful electric lights such as those at the Lizard, which did not prevent the "Suevic" from going ashore immediately beneath the lighthouse. On the contrary, there is something in the suggestion that their existence is deceptive to navigators, who in thick weather expect to sight them from a greater offing than the lack of penetrative power of the electric arc permits. Thus the experience of lighthouse authorities confirms that of highway and street lighting boards on the point of the uselessness of electric light in foggy weather.

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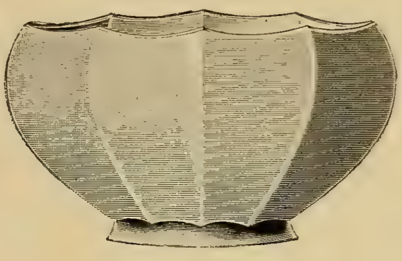

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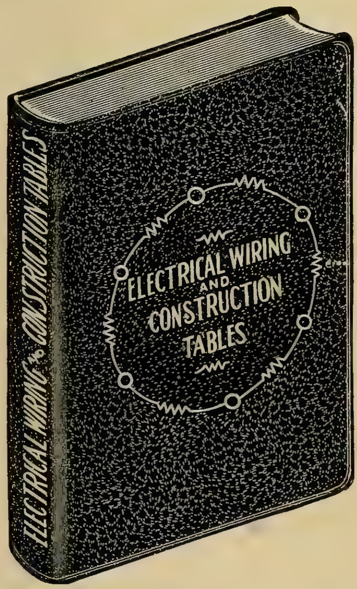

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A BATTERY OF SEARCH-LIGHTS PLAYING ON NIAGARA FALLS.

Undoubtedly the greatest single spectacle ever produced by artificial illumination is the lighting of Niagara Falls, which was first exhibited on the night of September 2. Thirty-one search-lights were used; 21 are below the bank, in what is known as the "Gorge Battery." This battery is composed of 18 to 30-inch projectors, and is located in a spot which is most advantageous in throwing the rays on the American and Horseshoe Falls. Above the bank is what is known as the Cliff Battery No. 1, situated on the spillway, of the Ontario Power Company, consisting of four 30-inch search-lights. Cliff Battery No. 2 is situated in Queen Victoria Park. The system was designed by Mr. W. D'A. Ryan, Illuminating Engineer of the General Electric Company. Twenty-five thousand spectators witnessed the first exhibition of the illumination.

THE ILLVMINATING ENGINEER

Vol. II. SEPTEMBER, 1907 No. 7.

Mind Your Eyes

By "Multipolaris."

The eye is the most delicate, the most complex, the most highly organized, the most valued, and the most generally abused organ of the human body. If your shoe hurts your foot, you put away the shoe with more or less sulphurous language expressed or thought; if an article of food distresses your stomach, you shun it thereafter; a discordant or piercing sound at once arouses your active and aggressive wrath resulting in an immediate abatement of the nuisance; bad odors are not to be tolerated for a moment; but your poor eyes are called upon to work with all kinds and conditions of light, and are taxed by strain and overwork to an extent to which you would not subject any other member of your bodily mechanism.

In one respect the eye is like the donkey—it courts abuse by reason of its almost unlimited patience. No matter how hard the task may be, the eye will go ahead and do it to the best of its ability without immediate strenuous complaint. The extreme range of light through which the eye is capable of working will be understood when we consider that we can read without serious discomfort, for a short time at least, in full sunlight, and also in dusk that is on the verge of total darkness. The difference in illumination between these two extremes is many hundred fold—running perhaps from 1/100 foot-candles to several hundred foot-candles. But while the eye is capable of work under widely varying conditions, it does not follow that work under favorable conditions, or overwork under the best of conditions, will not in the end result in injury.

Another reason why the eye is so often abused, is the rather curious fact that the immediate result of eye-strain is very often manifested, not by any pain or discomfort in the organs of vision themselves, but in an effect upon the nerve centers effecting other organs of the body. More headaches are due to eye-strain than there is any common conception of. The digestive organs are also sensitive to the effects upon the optic nerves. It is even claimed by good authority that seasickness is due primarily to

the peculiar strain caused by the attempt of the eye to maintain a position of stable equilibrium. Conversely, the eye is readily effected by abnormal conditions, or disease of other parts of the body.

The most serious and common menace to the eyes is the excessive brilliancy of modern light-sources. Science rightly claims to have made great progress in the production of artificial light, but this progress has been almost exclusively in the line of economy. Up to within a century ago artificial light was a luxury. The best light-sources were wax candles, which were so highly prized as to be used as votive offerings by religious devotees. In every case where a method has been found of producing light at less cost, the method has consisted in getting a more brilliant source. The difference between the brilliancy of a candle flame, and that of a modern arc lamp, fairly measures the progress that has been made in the methods of producing light.

But while these improvements have cheapened the cost, and hence increased the use of light, they have introduced conditions affecting the eyes, which have been almost entirely overlooked. Take for example, the familiar incandescent electric lamp Look at the lamp when it is not burning, and you observe a loop of what appears to be an exceedingly fine black wire. So fine is this wire that it can hardly be distinguished without holding it in front of a white surface. Turn on the current: this fine wire gives out as much light as a good-sized gas jet or oil lamp, and appears to be swollen to the thickness of the lead in a pencil. This apparent increase in thickness is an optical delusion, and a danger signal which proclaims in glowing speech, *"mind your eyes."* Now look at the lamp through a smoked glass, which cuts off a large part of the rays: the wire loop appears again in its natural size as a fine red streak.

When we see an object there is a picture of that object thrown upon the retina of the eye. The retina is the part on which the lens of the eye throws an image of whatever is before it, just as the lens in the camera throws an image upon the ground-glass screen. When an image falls upon the retina something happens; but just *what* happens science has not yet been able to fully discover. The result is plain enough, however—the picture is transformed into the mental sensation which we call "seeing." This retina is probably the most complex and exquisitely constructed organ in the whole human anatomy. It consists of a net-work of nerve fibers, connected with a marvelous apparatus of microscopic delicacy for receiving the light rays and changing them into nerve forces. Scientists assure us that this change is partly chemical and partly mechanical, and that both effects are destructive in their nature; but that the apparatus has the power of renewing itself, if not abused beyond its limit.

Now, when you looked at the bare lamp filament there was an image of this filament formed upon the retina, and this image was exceedingly bright, like the original object; so powerfully, in fact, did it affect the apparatus of the retina upon which it fell that the effect spread to the parts on each side of the line, much as the ink would spread out from a line drawn with a pen on blotting paper. This spreading caused the swollen appearance of the filament as seen. Such a spreading of the effect beyond its natural limits is a positive indication that the part of the retina upon which such brightness falls is being severely

overstrained; and it is only a question of time when such overstrain will destroy the visual apparatus beyond its power of complete recovery. The effect may be compared to carrying a weight in the hand. If a weight be distributed uniformly, so as to bear equally over the whole surface of the hand, no discomfort is felt; but attempt to carry the same weight attached to a string or wire, which bears only upon a small line of surface, and the resulting discomfort will very quickly produce sharp pain. If the weight be then released an angry red streak will still remain where the string or wire touched, and will continue to give discomfort for a length of time proportionate to the duration of the strain. So, if you look at the lamp filament for even a very short time, and then shut out all light by placing your hand over your eyes, you will still see the form of the glowing wire standing out vividly in a dark field. This after image may continue for several minutes If you close your eyes in a similar manner in any room with daylight illumination you will see only a slight effect of uniform dim illumination. This simple experiment of looking for the after image is as valuable as it is simple. If, on thus closing your eyes, you find a distinct and persistent after-image, you can be sure that your eyes are being unduly strained.

The electric lamp is by no means the only offender of this kind. Mantle gas burners, if unshaded, are just as bad, and the arc lamp the worst of all.

Do not make the mistake of supposing that such brilliant lights are harmless except when looked at directly. As a matter of fact they are even more dangerous when so placed as to shine into the eyes sidewise, or from above, since the eye is less accustomed to receive bright light from such directions. In other words, light from such directions falls upon the outer parts of the surface of the retina, which, being less accustomed to receive bright light, are the more quickly injured by it. Cases are on record where persons working in the vicinity of bare lamps so placed have entirely lost the sight of one or both eyes.

That there are not more serious injuries to the eyes from this cause is a proof of the remarkable facility of these organs to adapt themselves to unusual conditions, rather than to any thought or care in the use of the lights. Not only are unshaded lights placed indiscriminately as convenience may dictate, but in innumerable cases are so scattered about that it is impossible for the eye to escape getting the direct light from more or less of them. A Pullman railway car is a familiar and aggravating example; with its line of unshaded and brilliant gas flames down the center of the low ceiling, it is impossible to sit or look in any direction in which there is not one, but several of these lights shining directly into the eyes.

But the misplacing of lights is not the only way of abusing the eyes by forcing them to receive direct rays. Many people have the careless habit of sitting with their faces to the light when reading or doing other careful eye work. Fig. 1 shows a typical case. It is a reproduction of a work of art, and the artist deserves praise for the fidelity he has shown to the truth. To gather around a table facing the light is a most natural thing to do; and so long as the light is only an oil lamp, and that shaded with a porcelain reflector, as drawn by the artist, is not so bad, since the flame of the lamp is entirely hidden, and the porcelain reflector gives a very soft and diffused light; but even so, a position with the back or side

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FIG. I.—"THE EVENING LAMP."

turned toward the light so that the eye would not see the lamp at all would be better. The greatest trouble is, having used a shaded oil lamp in this manner, you are apt to take the same position around an unshaded electric or mantle gas lamp; then you begin to wink and blink, and thrust your knuckles into your eyes, until perhaps your eyes finally rebel altogether, and you rail at "these new-fangled lights" for being hard on the eyes. It is not the lights, but you, that is hard on your eyes. The whole difficulty can often be solved by simply changing your position. Fig. 2 might be properly given the same title as the one on the preceding page. It is not, however, taken from a work of art, but from the advertising matter of the acetylene interests, and it shows most admirably the proper position to take about a light, in order to see with the greatest comfort and protection to the eyes. Observe that every one is turned so that the light cannot shine directly into the eyes.

But, you ask, "are we to discard the electric light, and the mantle gas burner, and go back to candles and oil lamps?" By no means. Either of these can be made as pleasant and safe

FIG. 2.—RIGHT POSITIONS FOR READING.

to use as the oil lamp by taking a little care. Just remember that they are too bright to be used uncovered, and that therefore your lamp or burner should always be supplied with a good shade or reflector. You should never see the filament of a lamp or the mantle of a gas burner, when in use. Such shades may use up a portion of the light, but even then you will actually see better by what is left than you did by leaving the bare lamp to burn its image into your eye. In most cases, however, if you make the right selection, and arrange your lights properly, you will find that you will probably use even less candle-power than you did before.

There are some cases of faulty lighting in which the defects are so aggressively apparent that they are generally recognized, but not always avoided. Probably the most familiar of these is a light that flickers. The old-fashioned flame gas light was the worst offender in this regard; but since Welsbach burners have become so common and so cheap, to use a flickering gas flame can only be classed as criminal negligence. The electric lamp does not flicker, but may produce an effect which is equivalent to flicker, namely, streaks of light and shade on the object viewed. This applies particularly to cases of reading and writing. An electric lamp shining directly upon white paper will produce very decided streaks of light and shade; and some kinds of reflectors increase these streaks. In following a line of reading or writing one sees first a light and then comparatively a dark spot, which produces the same general effect on the eyes as a flickering light. The remedy is simple: use a frosted lamp.

Electric Lighting of a Colonial Cottage

By Joseph Insull.

FIG. I.—THE COTTAGE.

In arranging the electric lighting for a Colonial cottage built at Pittsfield, Mass., the writer had in mind the preservation of the perspective as shown in the following photograph, and with this object in view wall brackets are used almost entirely. Where center pendant fixtures are used, they are set close to the ceiling, and do not interfere with the line of sight. This is clearly shown in Fig. 3, a photograph of the hall, which is lighted from the center of the ceiling with a frosted cut crystal glass lantern close to the ceiling. The stairway is lighted by two meridian frosted lamps with Holophane glass reflectors and are hidden from the front view by being placed on the stairway side of the elliptical arch.

The music room shown in Fig. 5, has a center pendant fixture very close to the ceiling for general illumination

FIG. 2.—PERSPECTIVE FROM THE HALL, SHOWING LIBRARY AND DINING ROOM.

FIG. 3.—HALL AND STAIRWAY.

FIG. 4.—DINING ROOM.

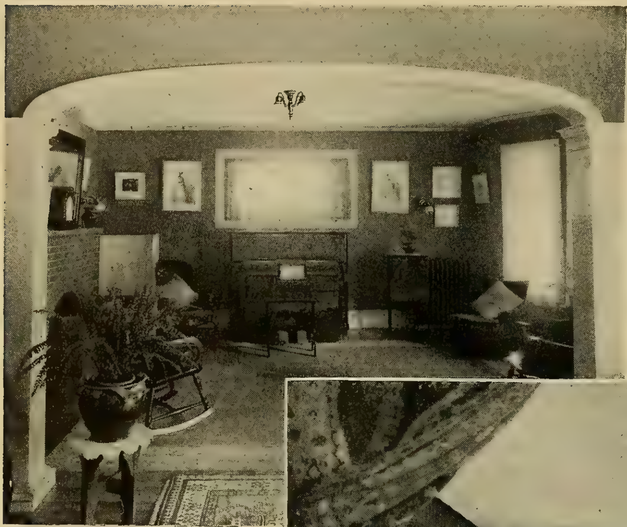

FIG. 5.—MUSIC ROOM.

FIG. 6.—LIBRARY.

and four wall bracket fixtures located near the four corners of the room.

The library, Fig. 6 is provided with six wall bracket fixtures, distributed around the room at about equal distances, affording convenient light for reading in every part of the room.

The dining-room, shown in Fig. 4, is provided with a center canopy fixture made of art glass frosted on the inside, the color of the glass blending with the general color scheme of the room. The glass is sufficiently transparent, so that it diffuses a softened light around the room, bringing into relief the pictures and decorations. There is also a wall bracket provided for service use when the canopy light is not required.

The landing shown in Fig. 7, is provided with two wall brackets, conveniently situated for reading.

All the wall brackets have a downward curve and are provided with frosted ball globes with an opening in the lower as well as the upper part. As the lighting is almost entirely from side brackets with frosted globes, the general lighting effect is very restful and the annoyance of brilliant points of light in line of sight is entirely avoided.

FIG. 7.—LANDING.

Colonial Lighting

Colonial architecture, which has been having a run of unusual popularity for a number of years past, is an adaptation of the elements of classical architecture to modern needs. This recurrence of classical forms seems to be one of the regular phenomena in architectural history. The reason for this periodical *renaissance* is sufficiently simple and apparent: Greek art is based upon the fundamental principles of æsthetics, which do not change. Having its noblest examples in the temples of ancient Greece, it has furnished models for all the ages since.

The lighting of a colonial residence with modern illuminants, is a task which the architect of the present day must solve for himself, since modern illuminants were unknown in this period. The oil lamps which were used for the better class of lighting in those days were quite as charming in their design as were the architectural adaptations. The candelabra were equally good. In some cases, these designs have been reproduced almost exactly, with the substitution of electricity or gas as an illuminant. While this satisfies the demand for harmony of design, it is a somewhat servile imitation. The fluted column, which is the most familiar characteristic of classical architecture, has also been much overdone by fixture designers; and the torch, which was never used for interior lighting, even in ancient times, has been still more overworked. There is an opportunity for some artisan, with a truly artistic appreciation of the fitness of things, to distinguish himself in the way of designing lighting fixtures suited to colonial architecture.

Studies of Notable Instalations

Mozart Hall, Berlin, Germany

In view of the fact that the recent remarkable improvements in means of producing electric light, both with the arc and incandescent types of lamp, had their origin in Germany, the study of the German methods of utilizing these lamps for illumination is of particular interest to American illuminating engineers.

The installation herewith illustrated is one of the latest, and may be considered one of the best examples of German practice. The feature that will at once impress, and perhaps astonish American illuminating engineers, is the use of arc lamps, carbon filament and tantalum incandescent lamps in close proximity.

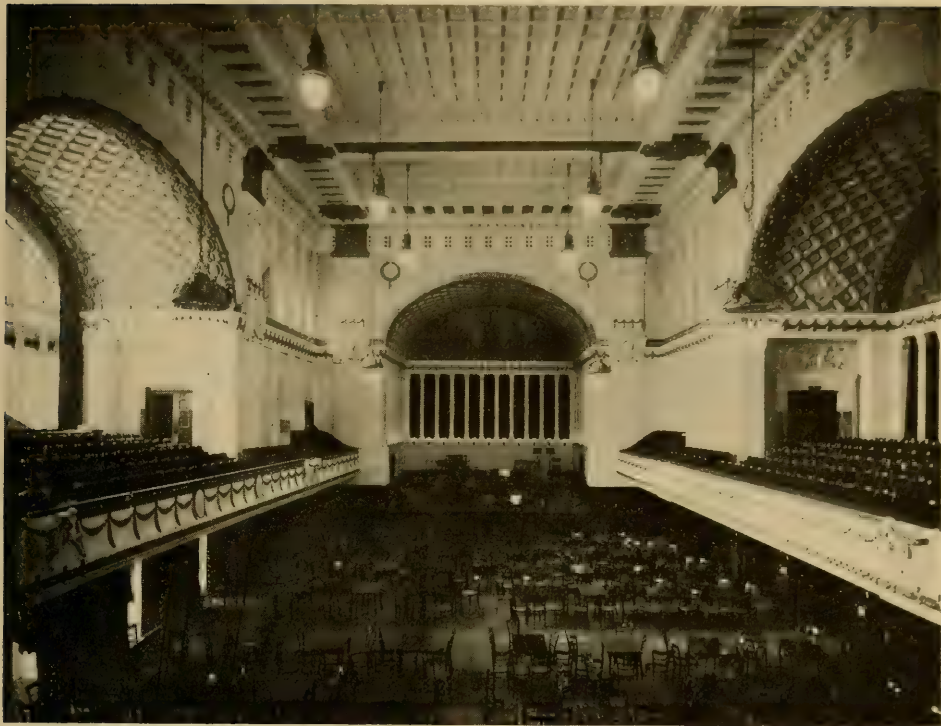

FIG. 1.—CONCERT HALL.

Fig. 1 shows the concert hall. This hall is 100 feet long, 50 feet wide, and 50 feet in height. There are four dome-shaped fixtures suspended by chains, each fixture carrying 44 incandescent lamps. There are also suspended from the ceiling eight 20 amp arc lamps, while 30 tantalum lamps are used under the galleries, making a total of 200 incandescent and eight high-power arc lamps used in the installation.

Fig. 2 shows a rotunda on the first gallery. The illumination here is by incandescent lamps set in rosettes in the panels of the dome-shaped ceiling, and also in the circle surrounding the dome.

Fig. 3 is a portion of the foyer of the first gallery; the illumination being by incandescent lamps in ceiling fixtures, in which bead fringe suspended in back of the lamps furnishes the decorative feature; the lamps themselves being covered with opalescent globes.

Fig. 4 shows the main entrance to the auditorium, which is illuminated by incandescent lamps studded on the beams, with ceiling bowls at the intersections. The entire absence of side brackets throughout the building is worthy of note.

Fig. 5 shows an exceedingly handsome decorative fixture, consisting of a large bowl of cut glass resting upon a polished marble base, forming a newel on the main staircase leading to the first gallery. The bowl contains 16 incandescent lamps.

There are 2,880 incandescent lamps and 2 arcs in the main theatre building and auditorium, while 590 incandescent lamps and 14 arcs are used in the

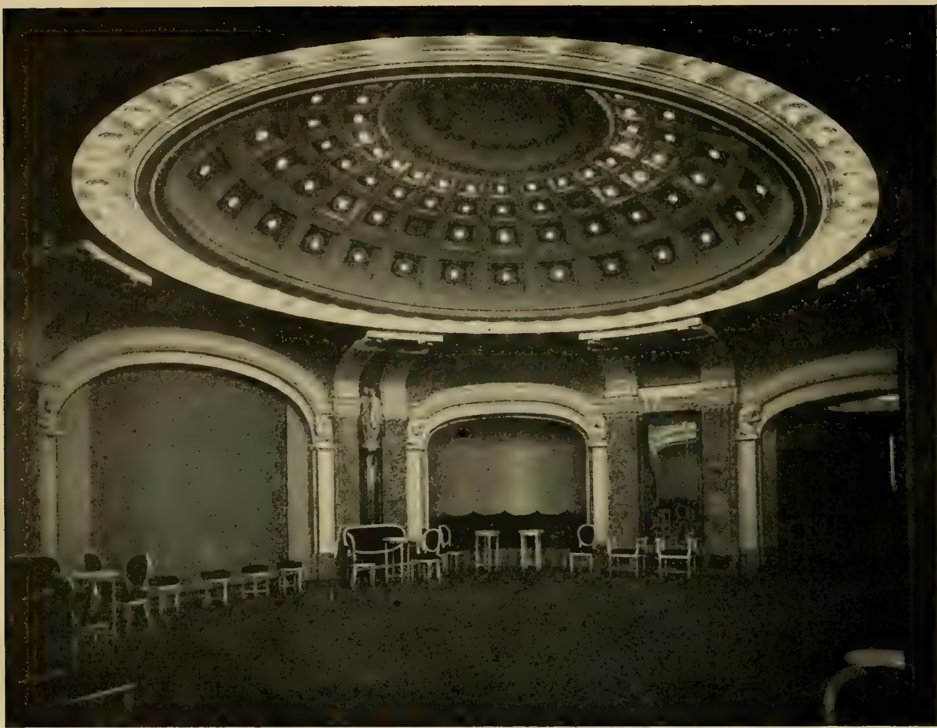

FIG. 2.—ROTUNDA ON FIRST GALLERY.

FIG. 3.—FOYER, FIRST GALLERY.

FIG. 4.—MAIN ENTRANCE.

Mozart Hall. There are 10 arc lamps and 1,210 incandescent lamps in the restaurant building attached, and the same number of arc lamps, together with nearly 500 incandescents in the manager's building. There is a large courtyard provided with 400 tantalum lamps, mounted on standards; the courtyard being used as a summer garden. The total number of lamps used in the buildings includes 2,000 tantalum lamps, 3,150 incandescents of 16 to 32 candle-power, and 36 arc lamps ranging from 3 to 20 amperes each.

It will be noted that the design of the fixtures, as well as the adaptation of the classical features of the architecture, is distinctly Teutonic. No one having the slightest familiarity with national characteristics would ever make the mistake of supposing any of the rooms illustrated to be in either Paris, London, or New York.

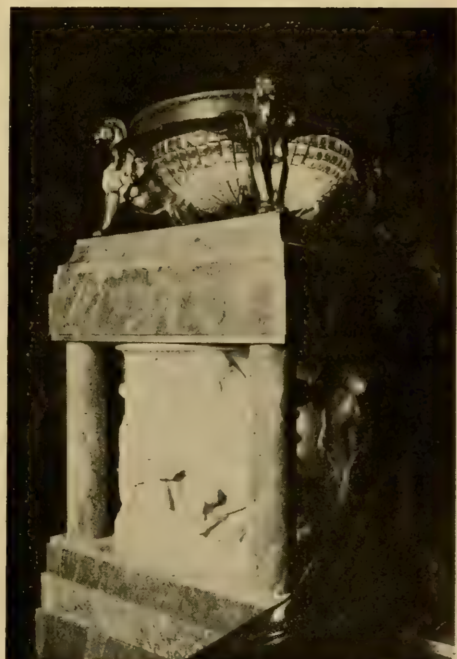

FIG. 5.—NEWELL ON MAIN STAIRWAY.

Theory and Technology

Daylight Illumination

By O. H. Basquin.

X. Flux Through Windows.

Effect of Wall Thickness. Up to this point the discussion has, in the main, been in answer to the questions what is the average daylight illumination at a given point in the face of a building or the average illumination over a given area. Let us now consider how much direct skylight gets into the room, *i. e.,* the flux through the windows.

We have already made use of a unit of flux corresponding to the lumen of the French system of units, viz., the current per unit solid angle about a point-source of unit intensity in all directions. By this definition the illumination is equal to the flux per unit area. From this it is clear that the flux which passes the window might be estimated by finding the average illumination on an imaginary plane in the window opening but coinciding with the inner face of the wall; this average when multiplied by the window area should give the total flux. It seems simpler, however, and more satisfactory, to take this problem up in a direct manner, and treat it on its own merits.

Effect of Wall Thickness. We shall first consider the thickness of the wall as related to the width of the window.

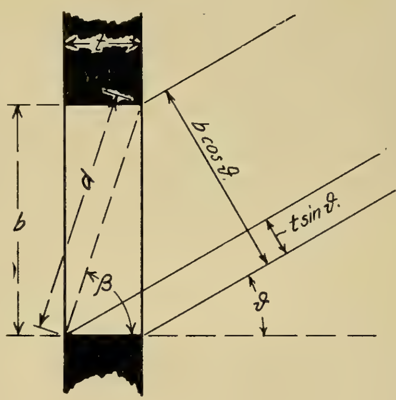

FIG. 1.

We may imagine the window as tall and as having a uniform horizon opposite it. Its ground plan is shown in Fig. 1, in which for the sake of simplicity the window is shown as having a rectangular cross-section. The width of the window in feet is represented by w and the thickness of the wall is represented by t.

In any direction making an angle θ with the normal, the apparent width of the outer face of the window is $w \cos \theta$. But some of the light coming from this direction falls upon the side of the window opening; for this reason the apparent width of the opening through which light can pass into the room is smaller, and is only

$w \cos \theta - t \sin \theta$.

We may now obtain a reduced width w_1 for the window by multiplying this expression by $d\,\theta$ and integrating it between the limits zero and the angle β shown in Fig. 1. The final result for the reduced width w_1 is

$$w_1 = (d - t).$$

In this expression d is the diagonal of the window section as shown in Fig. 1.

If the horizon opposite the window were a horizontal circle with its center at the window, then the total flux through the window would be strictly proportional to the reduced width above explained. In any case the error is not large and we may assume a direct proportionality in the general case. The flux entering the room is thus seen to be proportional, not to the width of the window, but to the difference between the diagonal and the wall thickness. As the diagonal does not differ greatly from the width of the window we may roughly say that the flux is proportional to the amount by which the window width exceeds the wall thickness.

The effect of the thickness of the wall upon the flux passing a window bears a relation also to the height of the window. A reduced height may be obtained in a manner quite similar to that used above for the reduced width. Practically the only difference is that the lower limit of integration is not zero but the angular height, α, of the horizon opposite the window. If we let D represent the diagonal of a vertical right-section of the window the reduced height h_1 may be written as

$$h_1 = D - h \sin\alpha - t \cos\alpha$$

in which h is the height of the window.

The flux entering the window is proportional to this reduced height. The reduction in the flux due to the wall thickness as related to the height of the window is likely to be considerably greater than that associated with its width. Not only is the thick wall objectionable, but a heavy window cap projecting from the face of the building is equally bad. A balcony or a porch which projects over a window is sure to cut off practically all the direct skylight except where the surrounding buildings are very low.

As an example let us compare the amount of light given by two windows, the first is 2 ft. wide by 4 ft. high in a wall 1 ft. thick where the opposite building presents an angular height of 30°; the second window is 4 ft. wide by 8 ft. high in a wall 2 ft. thick where the angular height opposite is 50°. For the first window the horizontal diagonal is 2.24, making w_1 equal to 1.24; the vertical diagonal is 4.12 and the reduced height is 1.25. The product of the reduced height and width is 1.55. For the second window the reduced width is 2.27 and the reduced height is 0.83 and their product is 1.88. The flux given by the two windows is, therefore, in the proportion of 1.55 to 1.88. Although the second window has four times the area of the first it gives only about 20% more direct light than the first one.

The actual flux through the window-opening is the above product of reduced height and width multiplied by π B, the flux being measured in the small units above explained. B is the sky-brightness.

Effect of Plain Glass. Plain glass is generally said to cut off about ten per cent. of the light incident upon it. This is approximately true for angles of incidence smaller than 30° or 40°, but is not true for large angles of incidence. The curve of Fig. 2 shows the percentage transmitted with variation in angle of incidence for a sample of plate glass tested in the labora-

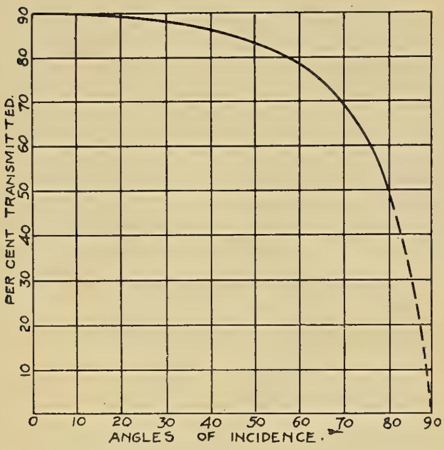

FIG. 2.

tory of the American Luxfer Prism Co. some years ago. The percentage transmitted by blown glass is likely to be greater than for plate glass because of the higher polish of the natural surface.

The curve shown in the figure may be fairly well described by the equation

$$p = 0.90 \cos \tfrac{1}{4} i.$$

in which p is the per cent. transmitted, and i is the angle of incidence. This is not an equation curve derived from the theory of the subject, but happens to fit the curve well enough for our purpose, which is now to obtain an expression for the flux through a square foot of glass standing in a vertical position and exposed to an open sky.

Consider an element of sky the light from which makes an angle of incidence i. In this direction the apparent area of the glass is cos i. The area of the strip of sky is $\pi \sin i \, di$ and the flux from it is

$$0.9 \pi B \sin i \cos \tfrac{5}{4} i \, di.$$

The integral of this over the whole sky gives the total flux as 0.4πB. With the glass transmitting perfectly the flux would be 0.5πB. The reduction caused by the glass is then at least 20%, whereas from the figure one gets the impression that it is only 10%.

The deception which the figure is likely to produce is similar to that of a diagram showing the candle-power of a lamp having a considerable maximum at an axis of symmetry, such as may be produced by a Holophane globe. In our case of the plain glass, the best conditions have been assumed in taking an open sky; the ordinary case will contain a larger percentage of diagonal light and hence we may be sure that a 20% reduction is a conservative estimate of the interference of glass with the flux through windows.

Effect of Horizontal Bars. Consider the interference caused by a single horizontal rectangular bar such as is formed by the meeting rails of the sash. Let it be of height a and width b. Assuming a uniform horizon of angular height α, we know that the obstruction furnished by the bar will be proportional to the flux cut-off. The illumination on the face of the bar is $\tfrac{1}{2}\pi B\ (1 - \sin\alpha)$. If we regard the bar as a foot long, the flux received on its face is

$$\tfrac{1}{2}\pi a B\ (1 - \sin\alpha.)$$

In a similar way the flux received by the horizontal face of the bar is

$$\tfrac{1}{2}\pi b B \quad \cos \alpha.$$

The total interference is the sum of the parts. The interesting thing about this result is that the horizontal dimension of the meeting rail cuts off more light in proportion to its size than the vertical face does. This is shown from the fact that $\cos\alpha$ is always larger than $(1 - \sin\alpha)$, except when α is zero, in which case they are equal. When α is 45° the horizontal face of a square meeting rail cuts off about two and a half times as much light as the vertical face does.

Let us take now a series of horizontal round bars, Fig. 3, each of diam-

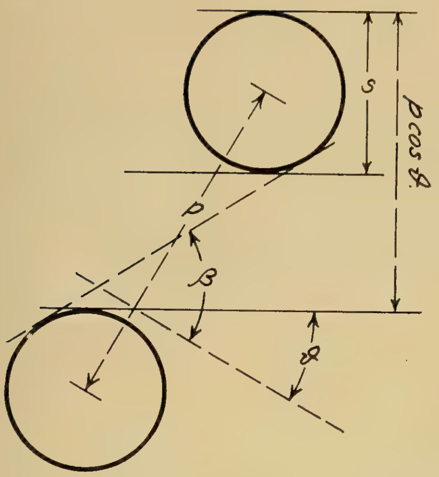

FIG. 3.

eter s and placed at a uniform distance apart p. We shall think of them as forming a screen or grating in a vertical plane before a window whose horizon has an angular height α. If we let m represent the fraction of the total flux which is permitted to pass through the grating it will be seen that the fundamental definition of m is

$$m = \frac{\int_{\alpha}^{\beta} (p \cos \theta - s)\, d\,\theta}{\int_{0}^{\frac{\pi}{2}} \cos \theta\, d\,\theta}$$

When this experience is integrated and reduced we find

$$m = \frac{p\,(\sin \beta - \sin \alpha) - s\,(B - \alpha)}{p\,(1 - \sin \alpha)}$$

If we assume that the distance between the bars is eight times their diameter, we have values for m as given in the following table:

α	m
0°	0.81
20°	0.78
40°	0.71
60°	0.57

Such bars then as cut out about one-eight of the aperture when viewed in a normal direction may be regarded as reducing the flux by about one-quarter in the average case.

Window screens are made up of both horizontal and vertical wires. We may look upon them as independent sets of straight wires superposed. The effect of the vertical wires will not be much different from that of horizontal wires in the case of the open horizon, viz., they reduce the result about 20%. The effect of a window screen in which the diameter of the wires is one-eighth their distance apart may be found by multiplying the values of m in the above table by 80%, thus obtaining the fraction of the flux which is transmitted through the screen.

Lace curtains have quite a different effect from that of window screens because their white fibrous texture acts as a diffusing screen, throwing into the room about half the light which they intercept.

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SPECIAL NOTICE: CHANGE OF DATE OF PUBLICATION.

Beginning with the October number, THE ILLUMINATING ENGINEER *will be issued on the 15th of each month.*

Markers Along the Path of Progress

If the path which illuminating engineering has taken were traced backward from the present time, it would be found in the very recent past to be scarcely more than scattering footprints, having only the common characteristic of pointing in the same direction. To the best of our knowledge the first mention in public print connecting illumination with engineering, was in the report of a paper on "The Utilization of Artificial Light" read before the New York Electrical Society in the winter of 1897, by the editor of this magazine, in which the expression, "lighting engineer" occurs; and the first use that we can find of the term, "illuminating engineer" is in an article by the same writer, contributed to *The Central Station* in the fall of 1902. These references may, therefore, fairly be said to represent the first finger-board: they pointed to the destination, and gave it a name.

That the use of artificial light to produce illumination had become a matter of such importance and complexity as to afford a special field for its study and application, was beginning to be realized by the professions in which the subject was most frequently met; but that this field was of such a character as to be included in the general domain of engineering was not at first recognized. Dr. Louis Bell, who brought out his admirable book in 1902, selected "The Art of Illumination" as the title; and although he treated the subject more as an art than a science, the appearance of his book may be rightfully considered the second finger-board along the path; it was the first work dealing exclusively with the subject of artificial illumination in all its various branches to appear in any language.

From this time the path became a regular thoroughfare, although followed but by few regular travelers. Among these pioneers the name of Van Rensaeller Lansingh is especially

worthy of mention. He was probably the first one to take up illuminating engineering as a practical, commercial proposition.

The formation of the Illuminating Engineering Society, in the fall of 1905, coincident with the issuing of the prospectus of The Illuminating Engineer, will remain for all time the most prominent marker in the whole course of progress. The formation of the Society was the final bringing together of all the individual by-ways, and their coalition into a single well-defined, definitely named, and publicly recognized highway; while The Illuminating Engineer is both a guide book and a log book for all pursuing this particular path of progress.

The fact that some opposition was met with in the formation of the Society only showed that its need was sufficiently felt as to make it a force to be reckoned with. A few members of the electrical engineering fraternity scented a rival to their own Institute in this new aspirant for professional favor. One electrical engineer of high standing declared that "he could see no more need of an 'Association of Illuminating Engineers' than for an 'Association of Armature Winders,' or of any other similar workmen." The large manufacturing interests evidently had some misgivings as to what might be the result of educating the public on the matter of illumination, but in the end had the foresight to join vigorously in the move, and make the new power their ally rather than their enemy.

Something of the same opposition of a negative character was encountered in establishing The Illuminating Engineer. The need of recognizing illuminating engineering as a distinct branch of science by the publication of a periodical devoted exclusively to the subject, or at least by running a special department in technical journals most nearly connected with the subject, was presented to the various publishers several months before the first move was made toward forming the Society. The only result, however, was a courteously expressed opinion that "the time was not yet ripe for such a publication," or that "the field was not sufficiently large to justify it." With but one or two exceptions, one or the other of these opinions was given, not only by the publishers of technical papers, but by those who, from their interest in the subject, would be supposed to have the keenest appreciation of its needs.

When the Society and the publication of The Illuminating Engineer had been once established, the rapidity of the progress of illuminating engineering astonished even the most optimistic of its advocates. Membership in the Society increased at a pace unprecedented in the growth of scientific associations, and The Illuminating Engineer acquired within a year a larger number of subscribers than the electrical journals had been able to secure in the first decade of their existence. That the need for such a publication was genuine was immediately recognized by the rapid increase in the number of articles on subjects pertaining to illumination, which appeared in the technical press. Naturally, the electrical and gas journals were the first to seize the opportunity of keeping in line with progress, and they were closely followed by journals dealing with other branches of engineering, such as civil and mechanical; and we have had the felicity of seeing an unexpected number of quotations from our pages even in the literary press. The latest recognition of this need, which we pointed out long ago, is the publication by one of the older electrical jour-

nals of an illuminating engineering number, to which special attention has been called by advertising and personal announcements.

Within the past eighteen months, the evidences of progress have been so many and so conspicuous that the mere mention of a few must suffice.

Two years ago, when the building which was to be the home of the leading engineering societies of this country was being planned, the importance and propriety of having an illuminating engineer retained, at least in a consulting capacity was called to the attention of the proper authorities by a competent practitioner who offered his services gratis. The whole matter, after being referred from one official to another through numerous committees and officers, was finally flatly declined. To-day the United States Government employs illuminating engineers on all of its important work; the foremost railroad corporation of the country has had an illuminating engineer making special investigations for the past year; while one of the largest central stations placed the lighting of its new office building in the hands of a commission of three well-known experts, and all the larger stations, and many of the smaller, regularly employ illuminating engineers.

The American Bridge Company, which is one of the constituents of the largest corporation in the world, in asking for tenders for lighting one of its new plants recently, furnished plans of the various buildings, specifying the general character of the illumination required in the various parts, and required those submitting bids to make their own specifications as to the kind, number, and position of the lighting units.

In 1906 the offer of a paper on illuminating engineering was refused by the program committee of the National Electric Light Association. In 1907 there were half a dozen papers on the program which would have been as appropriate for an illuminating engineering convention as for an electric light convention; and what was even more significant, a committee previously appointed to consider the question of street lighting contracts, reported in favor of basing prices upon the illumination furnished rather than upon lamps. This is the first case on record of a serious attempt to buy and sell light, as such.

The largest electrical manufacturing company in the world has a department of illuminating engineering which it maintained at a cost of $50,000 for the year ending January 1, 1907, and which, in addition to a large amount of valuable research work considered problems involving a money value of half a million dollars.

The largest manufacturer of gas burners in this country now has an illuminating engineer upon its staff, and so forth.

The simple fact is that the demand for illuminating engineering had existed so long before it was openly recognized by "giving it a local habitation and a name," that when this was done its growth was like the century plant, which, after a hundred years of slow acretion and storage of nourishment, bursts into full bloom in a month. Or, to use another form of metaphor more in keeping with present day sentiment, the public were "short" on illuminating engineering, and when once its true value became established, there was a general scramble to cover, and take the long side of the market. There are still a few "bears" in existence—mostly in architects' offices—but that they are on the wrong side is plainly evident from the few evidences above mentioned, and innumerable others which are to be seen on every hand.

Electric Light as Related to Architecture

The architect has usually been considered the *bete noir* of illuminating engineering,—and it must be admitted, with a considerable degree of reason. That there are some notable exceptions among architects, however, was conclusively proven by the remarkably pithy and instructive address at the recent convention of the Illuminating Engineering Society, by Mr. C. Howard Walker. It is unfortunate that many of the most valuable points of Mr. Walker's address were missed by the official stenographer, for the omission of a single sentence of his discourse will be a genuine loss to readers of the *Proceedings*. Mr. Walker not only understood his subject thoroughly, but had the happy faculty of setting forth his propositions and arguments in such vigorous and terse language as to leave a lasting impression upon all those who were fortunate enough to listen to him.

His observations on exterior display lighting were the result of sound theory backed by practical experience, and may therefore be taken as authoritative. Briefly put, they were as follows:

Display lighting accomplishes one of two purposes; it either accentuates the architectural features of the building, or it forms an individual spectacle in itself, with the building as a mere setting or background. If the former purpose is intended, the use of lights in outline, or singly, must be strictly limited to the salient features of the building. If the latter effect is desired, the architectural features of the building may be practically neglected, and the lamps arranged in any design which may suit the fancy. The display then is simply a scheme of permanent pyrotechnics.

Vertical lines of light have the effect of foreshortening the perspective, and should, therefore, never be used where vistas are desired,—as in many cases of exposition lighting. Horizontal lines, on the other hand, add to the effect of perspective.

Light represents a void, or empty space; light-sources should therefore be placed in recesses and panels, rather than on projecting or supporting parts. A most convincing illustration of this fact was shown in the indirect lighting of the hall in which the Convention was held. The ceiling is supported by two beams running lengthwise of the room. Along the lower edge of these beams a cove had been made in which lamps were concealed. The beam was thus brilliantly lighted, the illumination grading off on to the ceiling. As a result, to use Mr. Walker's happy expression, "the enormous columns were supporting a thin board, leaving the ceiling to be supported by Divine Providence."

As to the number and location of light-sources, the architectural unit, which is supposed to be repeated to make up the aggregation forming the building as a whole, should be maintained. According to this, a single fixture in a ceiling panel would be preferable to a number of light-sources distributed over the surface; and similarly in other cases.

Questioned as to the relative merits of the two schemes of exterior lighting, Mr. Walker wittily replied that "if the building really had architectural features worth preserving, the plan of simply accentuating them with light was preferable; but that there were only too many cases in which the more the architecture was disguised, the better it would appear."

Illuminating engineers must not fall into the errors and faults with which they charge the architect, *i. e.*, of as-

suming omniscience in their particular field of knowledge. There are at least some architects to whose advice and arguments they may listen with decided profit.

Color Values of Artificial Luminants

Under the title given above, Mr. Bassett Jones, Jr., contributes to the *Proceedings* a discussion on a paper presented by Mr. G. H. Stickney, to the New York section of the Illuminating Engineering Society, an abstract of which has already been published in our columns. We are not satisfied with the mere publication in full of Mr. Jones' admirable article, but wish to particularly call the attention of our readers to it.

The writer starts out with the statement that "the greatest difficulty that the illuminating engineer will have to contend with is the fact that, in the practice of his profession, he must be quite as much an artist as he is a scientist." This statement is both true and important. The profession offers only a career of failure to those who have no conception of the artistic. No amount of mathematics, however embelished with Greek letters and mysterious symbols; no array of curves and diagrams; no facile manipulation of watts and foot-candles, can ever take the place of that inate appreciation of the beautiful which is commonly characterized by the word "taste." There is no branch of craftmanship where the elements of good taste have been more outrageously subverted to the purposes of the almighty dollar than in the design and arrangement of the mechanical accessories of illumination.

Mr. Jones speaks feelingly, and therefore forcibly, upon this subject, in his discussion and it would be difficult to conceive more sound logic and wholesome advice on the subject than he has given in his contribution. It should be read and carefully pondered by every aspirant for illuminating engineering success.

A "Million-and-a-half Candle-Power" Light

In the description of the illumination of the Lackawanna terminal in our last issue, there was included among the features a description of a proposed globe which was to contain 49 flaming arc lamps, and which, according to the statement of the designer "would furnish a total of one and one-half million candle-power." In commenting on this, we may begin with the philosophical remark that "to exaggerate is American." Exaggeration forms the distinguishing feature of American humor, of which Mark Twain is the most shining example; but the saving grace of this writer's inimitable humor is the fact that with all his exaggeration, he in the end leaves not the slightest doubt as to what is exact truth. If this were always the case there would never be any harm in this form of literary amusement. The statement of scientific or technical facts, however, is not literature, and hence affords no legitimate opportunity for exaggeration. That it frequently creeps in to such matter is evident to anyone who is at all familiar with the ordinary Sunday newspaper treatment of scientific subjects. To the newspaper man everything that goes into print is a "story," and his one object is to make that story a good one. In the attempt to carry out his design such an unimportant matter as scientific accuracy is naturally relegated to the background. The statement recently appeared in some of the New York dailies that the

designer of this globe, which is simply a cluster of arc lamps placed as close together as possible and covered with a single globe, had discovered "a marvelous new light, giving a million candle-power," etc., etc. Given the number of lamps and the current which they consume, it is not a difficult matter to determine very nearly what the candle-power will be; and in the globe mentioned, which is to contain 49 lamps, the total candle-power may perhaps reach 100,000; it will certainly not exceed that. Now, 100,000 candle-power is a lot of light,—and probably more than has ever been produced from a single lighting fixture heretofore; but that word "million" has an exceedingly attractive sound, whether applied to dollars or candle-power, and as nobody will ever take the trouble to measure it, and as only one out of a thousand knows what a candle-power means, anyway, why should not the story be made big enough while the reporter is about it?

After all, the million-and-a-half candle-power lamp is no more of a mis-statement than to call the ordinary arc lamp a 2,000 candle-power lamp.

The Second Annual Meeting of the American Gas Institute

The second annual meeting of the American Gas Institute will be held at the New Willard Hotel, Washington, D. C., October 16, 17 and 18.

The American Gas Institute is an association which should occupy a similar position in the gas industry that the National Electric Light Association holds with reference to the electrical industries. While only in the second year of its existence, it is in reality much older, being a combination of a number of gas associations which had been in existence for some time. By this combination the Institute covers a very much broader field, both geographically and scientifically, than was covered by any of the individual associations, and its value to its members and its general influence in the gas industry should be proportionately enhanced. While there are always certain local conditions which have a more or less determining influence on the conduct of industrial enterprises, by far the more important elements of success are based upon principles which hold throughout the country; and there is always much to be learned from an interchange of experience from those working under different conditions, with different viewpoints, and different personalities.

The sessions of the Institute will be held in the auditorium of the hotel. Pres. Walton Clark will preside and the Hon. H. B. F. MacFarland, President of the Board of Commissioners of the District of Columbia, will deliver the address of welcome.

The full program of the meeting is as follows:

PAPERS:

Depreciation; by Mr. A. C. Humphreys.

Experience in Omaha on Delivering Uniform Candle-Power to Consumers; by Mr. George H. Waring.

The Obligations Imposed by the Possession of a Franchise; by Mr. Chas. H. Dickey.

Instructions for Operating Recuperative Benches; by Mr. W. A. Baehr.

Experiments in Carbonization; by Mr. W. H. Fulweiler.

Experience with Dipping Meters; reports from Baltimore, by Mr. A. S. Miller. Also reports from Philadelphia and Savannah.

Air Blast Gas Appliances; by Messrs. W. K. Eavenson, Philip Cross, W. J. Clark and W. H. Allen.

Lecture on "Electrolysis"; by Prof. A. F. Ganz.

REPORTS OF COMMITTEES:

Methods of Taking Candle-Power; by Mr. Wm. H. Gartley, Chairman, Philadelphia, Pa.

Public Policy Committee; Mr. E. G. Cowdery, Chairman.

Making of Rates and Additional System of Costs; Mr. W. H. Gardiner, Chairman.

Economic Balance Between Calorific Value and Candle-Power; Mr. Thos. D. Miller, Chairman.

Board of Revision; Mr. J. D. Shattuck, Chairman.

Electrolysis; Mr. A. G. Glasgow, Chairman.

Pipe Standards; Mr. Walton Forstall, Chairman.

"A" Meter Results from Philadelphia and Kansas City.

Uniformity of Meters; Mr. Chas. H. Dickey, Chairman.

Annual Meeting of the Empire State Gas and Electric Association

The annual meeting of the Empire State Gas and Electric Association will be held October 2, in the concert hall of the Madison Square Garden, New York City. An especially important and interesting program of papers has been prepared, which will be announced at an early date.

A joint meeting of the Association with the Street Railway Association of the State of New York will take place on the preceding evening, Oct. 1.

In view of the fact that gas and electric companies in this State are now under the general supervision of the Public Utilities Commission, arrangements are being made to have the Commissions of both the First (Greater New York) and Second Districts take an active part in the proceedings, and matters of the highest importance to both the companies and the commission will be considered. Additional interest is also added by the fact that the Electric Show will be in progress in the Garden at the time of the meeting. The general importance of the meeting, together with this special attraction should bring out a record-breaking attendance.

Illumination vs. Candle-Power

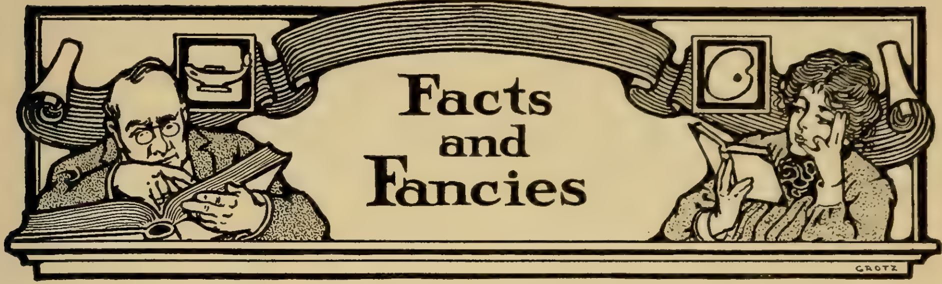
The agitation in favor of basing the payment for lighting, especially street lighting, upon measurements of illumination rather than upon candle-power, or a particular kind of lamp, does not meet with universal approval on the part of our English contemporaries.

The Electric Times (London), makes the following rather facetious comments upon the discussion of this subject at the recent convention of The Illuminating Engineering Society:

> It is, of course, not difficult to manufacture an expression that shall correctly represent illumination but it is no good because it would be as difficult to measure as mean spherical candle-power, and if measured quite as useless, since it would give no information as to whether at that point it was certainly possible to read a newspaper or recognize someone else's sweetheart.

That there are difficulties, even with the improved instruments that have lately been devised, in accurately measuring illumination on a plane at any given point, we are quite ready to admit; but we cannot agree that such measurements are "no good." At their worst they are certainly better than candle-power measurements as ordinarily applied to arc lamps.

The closing statement of our contemporary, that "even if illumination were measured it would be useless," shows a surprising disregard of the present status of illuminating engineering. A statement of the intensity of illumination in foot-candles would certainly give very definite information as to the possibility of reading a newspaper—at least an American newspaper. As to the foot-candles required to recognize someone else's sweetheart, that might depend somewhat upon her complexion.



The Cost of Lighting Fifty Years Ago

By G. Wilfred Pearce.

The earliest series of experiments made by a man of high scientific standing as an illuminating engineer for the purpose of determining the cost of electric light in comparison with other illuminants were carried out in Paris by Edmond Becquerel in the first half of 1857. He used in his experiments a dozen types of electric batteries, and the several patterns of electric lamps that had been recommended to him by the physicists of Europe and America who had given form to their ideas for electric lighting devices. Becquerel adopted as the standard of light 350 wax candles of the best quality, and of the size used for boudoir brackets. His final tabulations of costs established these figures:

Electric light	$0.58
Coal gas, at $1.60 per 1,000...	0.35
Oil, rape seed, at 17c. lb......	0.65
Stearine candles at 32c. lb.....	2.52
Wax candles, at 52c. lb.......	3.12

At that time the price of gas in New York was $2.50 per 1,000 cubic feet, and in Brooklyn and many other cities the price was $3.00 per 1,000 cubic feet. At those prices the electric light generated by the best then known methods was cheaper than gas light.

The Early Days of Gas Lighting

A Pictorial Reminiscence.

We are indebted to Mr. A. Canning Williams, secretary to the Reading Gas Company, for the photograph here reproduced of an old colored print which recently came into his possession, and which, presumably, refers to the early days of gas lighting. "From the words at the top of the picture," as Mr. Canning Williams writes, "it is evident that it forms the fifth of a series depicting the nuisances of London. Satire and humor are blended in the drawing, and one can imagine that even at the time when it first appeared it was provocative of more smiles than frowns among those commercially interested in the new lighting agent. I. Killem, a chymist and (doubtless) druggist, appears to have been of a sufficiently progressive turn of mind to

light his shop with gas. All went well for a time, but one day, just as a stately dame and her little top-hatted boy were passing in front of the premises, an explosion took place of such severity as to shatter the window, send flying in all directions the bottles and other miscellanea of his trade, and knock down the lady and her diminutive and somewhat maturely-attired son. Despite the gruesome suggestiveness of his name, Killem seems to be more concerned about the lady than he is at the loss of his property, and though much nearer the center of the explosion shows no sign of damage."

One of the Advantages of OIL over GAS.

A fortnight ago we published (p. 643) a copy of a photograph of an old print entitled "One of the Advantages of Gas Over Oil." A companion print, here reproduced, reaches us this week, by the courtesy of Mr. G. W. Anderson, of 5 Victoria street, London, S. W. It is, like its predecessor of two weeks ago, one of a large number of prints in a most interesting old volume, published at four guineas, entitled "Cruikshankiana, an Assemblage of the Most Celebrated Works of George Cruikshank." At the foot of both prints appear the name of the "invt. et sculp," Richard Dighton, and the name of the publisher, Thos. M'Lean, 26 Haymarket, London. The date of the publication appears to be 1835.—*From Gas World, London.*

Illuminating Paintings

Method Explained by Prof. Wood of Johns Hopkins University.

The optical intensification of paintings was the subject of a recent lecture in McCoy Hall by R. W. Wood, professor of experimental physics at Johns Hopkins University. The following report of it is published in the *Scientific American:*

"One of the great difficulties which the artist has to contend with in representing scenes in which great contrasts of luminosity occur is the comparatively narrow range of luminosity obtainable on canvas with pigments. According to Aubert, the whitest paper is only 57 times as luminous as the darkest black paper, and this probably represents about the range obtainable in paintings.

"Contrast with this the enormous range of luminosity in a sunlit landscape, where the high lights are many hundred times brighter than the deep shadows, to say nothing of sunset views, where the disc of the sun itself is to appear in the picture. As is well known, the colors of natural objects change in tint as the illumination is increased, green becoming yellowish for example, and artists, by taking advantage of this circumstance, consciously or unconsciously are able to suggest a high degree of illumination without actually reproducing it.

"Pictures are sometimes improved by strong local illumination. Anyone who has spent much time in sketching must have frequently noticed what pleasing effects are sometimes produced when a ray of sunlight, filtering through the trees, falls upon that portion of the canvas which represents, say, a sunlit meadow. Noticing effects of this kind so frequently, I have been led to experiment with carefully graded illumination, and have obtained results of remarkable beauty. If we can produce a strong illumination on all of the high lights of the picture and a feeble illumination on all of the shadows, we shall obviously greatly increase the range of luminosity. This may be done by a very simple means. We have only to take a photograph of the painting or an orthochromatic plate, preferably on a red sensitive plate, with a suitable ray filter, make a lantern slide from the negative, and project this picture, not on a white screen, as is usually the case, but upon the original painting. The experiment is to be made in a darkened room, of course.

"Effects of a very startling nature are produced in this way, especially in the case of moonlight and sunset pictures with fine cloud effects. The most striking and artistically the most pleasing subject which I have yet tried is a little pastel of the market place in Concarneau, by Bullfield, which is a wonderfully sunny picture. Under the graded illumination of the lantern the picture becomes filled with a perfect flood of sunlight, and we feel at once that here, for the first time, we are looking at a picture in which the enormous luminosity contrasts of nature are really approached. If, after looking at the picture illuminated in this way for a few minutes, we remove the slide from the lantern, allowing a uniform illumination to fall upon it, we feel a decided shock. The picture looks as if it had not been dusted for ten years, the sunlight leaves it and everything looks flat. As we become accustomed once more to the usual illumination the appearance of the picture gradually improves.

"It is most curious, however, to note how a short view of the painting under the light of the lantern educates us at once to a higher standard of luminosity contrast, so much so, in fact, that the picture at once strikes us as a very feeble attempt at anything like correct values, when we change suddenly to ordinary illumination. The effects are very different, according to whether we take our negative on an ordinary or on an orthochromatic plate, especially if there is much blue in the picture. We can in this way alter the relation of the values in the picture and study the effect.

"It is my opinion that if the values are correct in the original painting, they will hold under the graded illumination produced by the lantern. If they are not right, the errors will be glaringly magnified. As yet I have not had an opportunity to experiment with many pictures, but the method is so easily carried out that anyone having a good lantern can repeat the experiment.

"The method is, of course, of very little practical importance, though a small exhibition of suitable pictures illuminated in this way would be well worth attending. Each picture would have to be illuminated by a separate lantern, of course.

"Very likely scenic effects on the stage could be heightened by employing this method of illumination or some modification of it. The drop curtain could certainly be illuminated to advantage by means of a lantern in the balcony."

Has Artificial Light Killed Conversation?

One frequently hears it said that conversation, like letter writing, is now a lost art. Its decay is commonly attributed to increased pressure of business matters and to the modern tendency to "hustle." It had certainly never occurred to one to attribute it to the improved means of artificial lighting. One of our nineteenth century essayists—Charles Lamb, was it not?—describes somewhere the disheartening effect of indulging in witticisms by dim candle-light, by which it was impossible to read on the faces of the listeners the success, or otherwise, of the effort. It might have been supposed that the removal of this difficulty by the introduction of more efficient methods of illumination would have improved the art of conversation. But, according to a writer in the *Boston Herald* (quoted by the *Westminster Gazette*), the effect has been of quite an opposite kind. This gentleman, we are told, "points out that a few generations ago people had to pass their evenings in the light of flickering candles, which made reading difficult. When the argand lamp appeared, the members of the household, instead of discussing interesting problems with one another, spent their time in reading about them in books and magazines. Since then improved gas burners and the electric light have done even more to make talking out of date." In this ingenious theory may we not have a full explanation of the difficulty sometimes experienced in raising discussions at gas managers' meetings? Debate is, after all, but a glorified kind of conversation (sometimes, perhaps, with the glory left out), and may not the cause of any deficiency among the gas fraternity in this regard be found in the circumstance that they have to pass so much of their time under the rays of powerful lights of one kind and another?—*From Gas World, London.*

Go to the Ant, Thou Sluggard!

It is always a little unsafe to base arguments upon the technical reports of the daily press. Therefore station engineers need not be panic-stricken over Mr. Edison's latest statements. Electric glow lamps fifty years hence will only be using

one-tenth of the present energy per candle-power. It looks as if the curve of consumption per candle-power would fall so rapidly that the rise in lamps connected would be quite neutralized. "Was it not the *testudo* that taught us to build our tubes? Did not the bee correct our mathematics in the matter of hexagons? Are we not still seeking of the bird the secret of flight?" Go to the glow-worm, thou sluggard! One-fiftieth part of her secret would mean an emperor's ransom. We are too heartily tired of the glow-worm to seek her company. The testudo and the hexagon are really small matters compared with the value placed upon one-fiftieth of a secret. Manufacturers divide their secret processes into six or eight water-tight compartments. If one-sixth of a secret is not of much value it is difficult to see how one-fiftieth should "constitute a fortune far greater than the one that London lost over the water supply." Of course that assumes that the glow-worm does not divide her confidence among fifty shareholders. The joint patent, if workable, would probably be worth more than Coalite.—*From the Electrical Times, London.*

A Standardized Truth Teller

Mr. Furness testified to the great usefulness of a portable photometer in silencing all disputes. At Blackpool they have a kind of standardized truth-teller. Exactly how it works in determining the accuracy of a meter is not clear, for it really seems to be a photometer. But its effect is magical: "We very quickly satisfy consumers that they are in the wrong." Again, should the least question arise upon the relative illuminating power of gas and electricity in the streets, an application of this photometer never fails to clinch the argument. Of course we all understood what was really meant, but a mischievous interpretation of Mr. Furness's words was irresistible. Everyone laughed very heartily at the idea of a weapon which might be so faithfully depended upon to rout the enemy. No doubt the Blackpool photometer is perfectly impartial. The fact is that nine complaints out of ten are quite unreasonable.—*From Electrical Times, London.*

A Revolver That Fires Illuminating Bullets

An interesting novelty has been introduced recently in the German military field exercises conducted in the night by certain organizations, namely, the use of a revolver with illuminating bullets. The weapon has the general appearance of an ordinary army revolver, but is somewhat larger in caliber as well as in general dimensions.

The bullets after firing become illuminating bullets. The discharge is practically noiseless; the bullet rises to about 100 yards and has a range of more than 100 yards. The landscape in the vicinity is lit up as bright as daylight for about half a minute by the bullet, thus enabling the attacking troops to reconnoiter effectively and to detect readily the presence of any hostile troops.

On falling to the ground or on buildings these illuminating bullets do not burn or set fire to combustible objects, and therefore are not dangerous to use in localities where fires may prove as disadvantageous to the attacking troops as to the enemy.—*From the New York Sun.*

Life's Amusing Side

A young married woman entered a hardware store and asked:

"Have you got those things for improving a gaslight?"

"Yes, madam," said the dealer. "Here is a complete set, fittings, chimney and mantle——"

"Oh! I don't want the set!" said the woman. "I've got the mantle part and the chimney, but the little white shirt is busted; that's the only one I want."

Commercial Engineering of Illumination

New Publications

"Typical Installations of Cooper-Hewitt Lamps"; *Cooper-Hewitt Elec. Co.,* 220 West 29th St., New York.

A small pamphlet giving a list of installations of Cooper-Hewett lamps in various classes of use. As would be expected, the list shows that by far the largest use of the lamps is in connection with various manufacturing plants. The largest installation, outside the Westinghouse Electric Company, is that of the Government Printing Office in Washington, which uses 1,000 of the type "H," and the second largest, the Otis Elevator Company, in its plants in Yonkers, Buffalo, and Chicago, in which there is a total of 251 lamps. Eighteen cases are given of their use in drafting-rooms, and thirteen of installations in offices. Printing establishments seem to be second to factories in the number used.

New Apparatus

A new design of reflector has recently been brought out by the National X-Ray Reflector Co., 247 Jackson Boulevard, Chicago, Ill., which should prove a real acquisition to illuminating engineers in solving problems of show window, and other specially directed illumination. The following description and photometric data, with the several useful suggestions for their use, have been kindly furnished us by the manufacturers. It is evident from the information given that in designing this new reflector the manufacturers were guided by strictly scientific illuminating engineering principles, and thus proved themselves to be progressive and up-to-date manufacturers.

The New X-Ray "Helmet" Reflector.

This reflector is designated the "Helmet" Reflector. It is especially designed to meet the requirements of lighting high and shallow windows; many windows at the present time being of this class. It is suited to the lighting of all windows over 12 ft. high where the depth of the window is less than one-half the height of the lamps above the bottom of the window, where the lamps are as high above the level of the top of the back of the window as the window is deep. This meets the condition in a great many of windows at the present time. It is intended to produce an approximately uniform illumination over the goods as ordinarily placed in show windows. This reflector marks a most decided advance over anything heretofore offered for lighting this class of windows.

In the first place, it is designed to use a 125-watt Gem incandescent lamp; thus giving the advantage over the old-style carbon filament that it will also take a 105-watt tungsten lamp; so that the user can install these lamps as soon as they are placed on the market. Future improvements in incandescent lamps have therefore been anticipated. Fig. 1 shows the external appearance of this reflector as viewed from

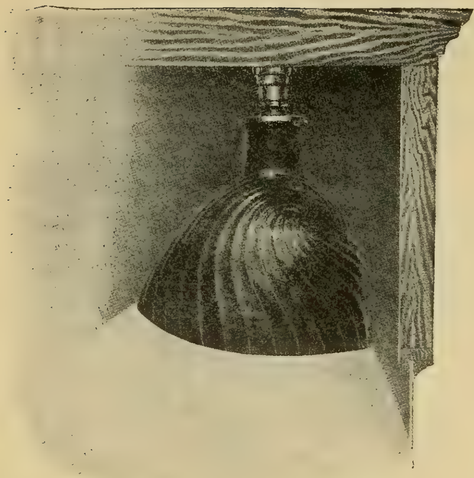
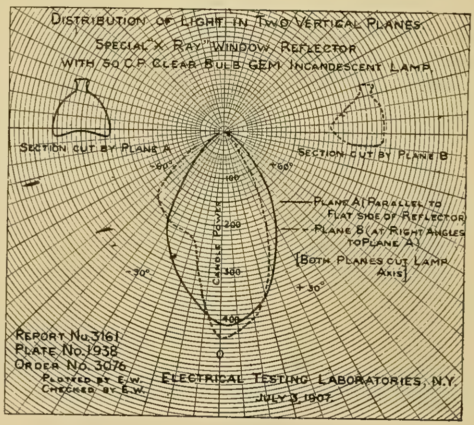


FIG. 1.

one side partially flattened and extended down lower than the rest of the reflector. This flat side is placed next to and parallel with the window pane, and is designed to avoid as far as possible the wasting of light on the sidewalk and detracting from the value of the window illumination, by exposing the lamp to the passers-by. The reflector is unusually large, being about 12½ ins. in diameter and 11½ ins. high. This size was necessary to secure high efficiency of window illumination by catching as much of the light as possible and reflecting it in useful directions. Another important reason for the peculiar shape of the reflector was to make it easy to install without mistakes. The makers realized in adopting this design that many excellent reflectors of conical form are commonly misused in window lighting because the average person who installs and uses these reflectors does not understand the importance of pointing them at the proper angle. This new reflector was therefore designed so that it is practically impossible to improperly install them and it is designed so that the lamps point straight down. It is only necessary to install a row of wall sockets pointing straight down along the top of the window and to place the reflectors on the sockets with their flat sides parallel with the window pane, just as one would naturally do without instructions. Their efficient installation is therefore very simple. Furthermore, by having the lamps pendant, use can be made of the new tungsten lamp, which would not be the case if the lamps were at an angle. The efficiency of this reflector for window illumination for the size of windows for which it is intended is remarkably high, as can be seen from Fig. 2, which is photometric curves plotted from tests made by the Electrical Testing Laboratories, of New York. In these tests the reflector was equipped with a 125-watt clear-bulb Gem lamp, giving 50 mean horizontal candle-power. The reflector was held in a position as used in practice with a standard 3¼-in. holder. The lamp was placed in such a position that the plane parallel to the loops of the filament made an angle of 45 degrees with the flat side of the reflector. In Fig. 2 are shown the apparent candle-power at various angles in a plane at right angles to the flat side of the reflector, and the apparent candle-power at various angles in a plane parallel to the flat side of the reflector, or, in other words, the sideways distribution, as it would be installed in a window. From Fig. 2 it is seen that over 200 candle-power is given for a distance of 40 degrees to the left of the vertical in the direction in which it is most useful in window lighting; while for a few degrees the candle-power is 436. The maximum candle-power is directed so as to give high illumination on the goods placed in the bottom and front of the window. As higher goods are usually placed further back in the window, a lower intensity is needed; and these requirements are met by the reflector. A very small amount of light is thrown outside the window on the sidewalk.

With a reflector of such weight, it is well



F.G. 2.

to have it in good mechanical balance to avoid the twisting of shade holders and sockets. The weight is distributed in this reflector so as to secure such a balance.

Besides window lighting a number of other useful applications of this reflector will suggest themselves to illuminating engineers—most notably the lighting of audience rooms of all kinds where the lamps themselves are concealed behind ground glass, skylights, or beams, and where it is desired to throw the light sideways and forwards and have as few rays directed back into the eyes of the audience as possible.

For the lighting of high, shallow windows, the makers are putting out this reflector with the claim, based on these photometric curves that one 125-watt Gem lamp with this reflector will give the same results as three 55-watt common incandescent lamps used in the most efficient window reflectors for high, deep windows that have been offered up to the time this reflector was designed, while in the many cases where mirror troughs or other reflectors unsuited to such windows, have heretofore been used, one 125-watt Gem lamp will give the same results as four or five common 16-c.p., 55-watt lamps. With tungsten lamps, having twice the efficiency of Gem lamps, the saving would be even more marked. The makers claim the honor of being the first to put out a window reflector designed for the new large high-efficiency incandescent lamps. Those who have tried their goods, know that besides correct design they have a reflecting surface that does not depreciate and fall to pieces with age as do common plate mirror reflectors used in windows.

Electricity as a Factor in Advertising.

By Bury Irwin Dasent.

Advertising Manager of Portland Railway, Light & Power Co.

An address delivered before the convention of the Pacific Coast Advertising Men's Association at Sacramento, California, July 19, 1907.

Curiously enough, the selection of the human vision upon which to concentrate the appeal of the advertisement, like most rules of human conduct, finds its justification in a law of nature. It is stated by a German scientist in regard to the sensitiveness of the eye that the persistence of visual impressions tends to form a retinal image which is transferred to the brain centers. Optically, this statement is not of startling novelty, for the eye is an organ that has been developed through ages of evolution, but physiologically it is of deep significance in any consideration of the relation of electric light to advertising.

The ultimate aim of any advertiser is to make the name of his product as nearly standard as possible, so that when you think of that particular article or experience a desire for it, you will recollect *his* brand, the kind *he* makes—and to attain this end most readily his advertising must be so devised that a retinal image of this particular product, or of its name or brand, is readily transferred to the brain of the public.

What devotee can readily forego the spell cast by the electric time-recording sign with its direct command "Time to Take a Wilson High Ball" when seated in club or café, after watching the marvelous working of its electric mechanism and play of light—all-powerful in the formation of a retinal image.

In order to sell goods the merchant must show them, and that, too, under the most favorable conditions. The newspaper advertisement of goods, however cleverly constructed, clearly fails to afford the prospective purchaser the satisfaction so readily secured by visual impressions.

There is no retinal image to be derived from a perusal of the conventional newspaper advertisement, such as may instantly be gained by a glance into a brilliantly illuminated show window radiant with electric light. Displayed thus favorably, the merchant's wares take on a new character. Under the well diffused illumination afforded by electricity the various articles are seen "true to life" as to color, size, and shape, while every minute detail of texture and of fabric is revealed in the beautiful, soft, unobtrusive light, sunlight in character and brilliancy, but infinitely more dependable. Here you have the zenith of cumulative visual impression, the absolute perfection of the art and theory of illustrative advertising—the one perfect appeal to the eye, to the senses, to the fancy, to the humor, to the reason! The appeal which the advertising writer has vainly striven to get, with word picture and artist's pencil, from the printed page; the appeal to every fiber of the human, the irresistible visual appeal of Electric Light!

The enormous increase in the use of

Electric Signs in Portland and indeed throughout the United States simply means that merchants have begun to realize their tremendous possibilities as trade-bringers. Frank R. Woodward, Director of Publicity for the Gunning System of Out-door Advertising, said in a recent address, "The test of the pudding is in the eating, and there is but little question that of all forms of out-of-door advertising none has stood the test so well as the electric sign. The rapid increase in their use, the comparative low cost of operation and maintenance, has made them exceedingly popular, and the man who is bidding for the public's patronage and fails to use the electric sign is not improving his opportunities. It is a safe statement and entirely within reason that 100 people see an electric sign at night where one person sees an ordinary sign in daylight."

The business men of Portland who employ electric signs are up-to-date and keenly alive to their opportunities and necessities.

Advantageously located in the shopping district, these electric signs are seen by thousands of pairs of eyes during the daylight hours; but it is at night, when the electric current illumines the many lamps of which they are composed, that these silent salesmen accomplish the most good.

Electric signs have assumed such importance in the business-getting plans of progressive merchants that even staid and conservative concerns such as banks have been brought to a realization of their value. A prominent banking institution of Portland last winter broke away from its hidebound traditions of conservatism and installed an electric sign of the "flasher and chaser" variety, bearing the legend, "We Pay Four Per Cent." It was something unique for an establishment so dignified, but what was the result? The day after its installation a stranger entered the bank and depositing $10,000 remarked, "I don't reside in your city—but I happened to see your electric sign last night, and was so impressed that I decided to open an account with you."

This sign is a large and expensive one, but I have been assured by an officer of the bank that the profits traced directly to its influence paid for the sign within eight days after its installation. Looking between the letters of the electric sign one always reads "Prosperity."

It must not be forgotten that practical needs must be considered quite as seriously as æsthetic aspirations, especially in a domain of so great and general importance as advertising.

The advertising man must, of all men, be free from the fetters of convention. We are some of us fettered by training, by tradition, by precedent, and venture too little beyond our immediate conditions to be able to rise to the portrayal of images of individual originality. We must not forget that just so long as life lasts and impressionability and plasticity remain, humanity is always adapting itself to its environment and seeking—originality!

Let us be honest with ourselves—with our clients! Throw tradition to the winds and break loose from the fetters of custom. If we find that the electric sign is the best media for our client, let us recommend its use. Nothing can ever replace the newspaper as the logical medium of publicity. Its position is unassailable, but there is a place for the electric sign, a most important place—and one of no mean proportions. We all realize the importance of the selection of the right media to NATIONAL ADVERTISERS.

It is not significant that the National Advertisers have taken up the Electric Display Signs and are rapidly installing them in all the larger cities of the country as well as on their factories and salesrooms. The railroads with all their advantages in the distribution of literature concerning their systems are yet liberal users of electric signs. I tell you seriously that there is absolutely no business, no attraction, that appeals to the public, that cannot be intensified, built up, and advanced by the proper use of Display Electric Sign Advertising. Even the churches are installing electric signs, as we find in the cities of Brooklyn, N. Y., and Cleveland, Ohio, where electric signs have been installed by houses of worship with gratifying success.

In Denver, Colorado, the citizens have erected a great arch, which stands inside the grounds of their Union Railway Station, and which bears a monster electric sign with the word "Welcome"—a perennial smile upon the face of their city, and a blazing salutation to the stranger at their gates. This is municipal advertising of a high order, and the fame of Denver's electric "Welcome" has spread throughout the United States.

In many cities throughout the country, enterprising merchants nave combined to secure the effective advertising of particu-

lar sections and streets by the adoption and installation of an especially efficient scheme of special street illumination, using incandescent lamps of high candle-power. Experience has shown that where a street, formerly dark and unattractive, has been so illuminated, a business reanimation has speedily followed. The city of Portland is now experiencing this renaissance of street illumination. The transitional movement in streets and sections so lighted is characterized by an unquestioned business revival, and as a result the Portland Railway, Light & Power Company is now engaged in the installation of these lamps in various sections of the city for business men who are interested in the stimulation of trade and the improving of the lighting in the vicinity of their places of business, and for the further purpose of beautifying and advertising the streets in which their stores are situated. It has been realized by the enterprising business men of Portland that this plan of special illumination forms an advertising feature of tremendous value, and one that is absolutely necessary if they would keep abreast of the times.

The great increase in the use of electric signs, and the ever widening utilization of electric light for purposes of advertising in Portland is not surprising. Wide-awake communities throughout the United States have all adopted this powerful means of publicity, and the public has come to look upon these messages written in electric light as convincing evidence of the enterprise and up-to-date character of the business houses which utilize them.

Perhaps no feature has contributed more largely to the growing popularity of this means of advertising, than the easy adaptability and flexibility of the electric sign in fulfilling the requirements of advertisers, while the low cost which attends even a lavish employment of electric current, for purposes of advertisement forms an additional reason for its universal use.

The sign of the times in Portland is, beyond doubt, the electric sign. At least that is the impression gained during a stroll through the streets of the business district after nightfall. On every side are seen electric signs of all shapes, sizes and colors, advertising every kind of business, and not only branding their legends upon the brains of the multitude, but proclaiming that here is an up-to-date banking establishment, there a progressive clothier, here a furniture store that has forged to the front, there a business man who believes in modern methods of merchandising.

To the electric sign, Portland owes its brilliant thoroughfares, and its air of metropolitan gaiety throughout the hours of the evening. With shops and streets ablaze with electric light many more people venture out at night, and if anything, the throngs are now greater after nightfall than in the daytime.

The electric illumination of Portland's shopping district constitutes a spectacle that is free for the enjoyment of all, and the great public loves spectacular effects, and will go a long way to see and enjoy them. Until this electric era began, the merchant put up his shutters or pulled down his shades when he closed the doors of his store. His expenses—rent, salaries, insurance, all went on, but his business stopped. That was the ancient way. With the modern way—the electric way—business no longer slumbers, for the store keeps glittering eyes open for trade throughout the lingering hours of the night, and whets the desires of the multitude by tempting displays under the glittering rays of the electric lamps.

TRADE FOLLOWS THE LIGHT, wherever that light may be placed, and the allurements of electric light and electric signs are but the working out of the same natural law that draws the moth to the lighted candle. No other form of advertising is so effective, so insistent, and so inexpensive in proportion to the business it brings in. The initial cost of an electric sign is small, and at the present low rates for current from the mains of the Portland Railway, Light & Power Company, the cost of maintenance is trifling.

Electric signs are all conspicuous in the daytime, but, brilliantly illuminated at night by electric light, they compel the attention of the evening crowds upon the streets, and it is largely due to this successful means of publicity that Portland's business thoroughfares have advanced more than 200 per cent. in brilliancy of illumination within the last year.

The Illuminating Engineering Society

The Inverted Gas Light

By T. J. Litle, Jr.

Paper read at the First Annual Convention of the Illuminating Engineering Society, Boston, July 30-31, 1907.

Much has been written concerning the historical development of the Inverted Gas Light, but I shall purposely avoid this. As the scheme appeared so attractive it is not surprising that inventors on both sides of the Atlantic have been giving it their attention for the past few years. Many unfavorable critcisms have been brought forward to discredit the system, but they have been proved unfounded by the instant success of all installations properly installed. It must be remembered, however, that an inverted light improperly installed will be open to criticism just as would any other form of incandescent gas light under similar conditions, and in this connection, I should like to say that the success of gas lighting is contingent upon the proper installation of the most efficient appliance, coupled with its subsequent maintenance, either by the company making the installation, or, by very carefully drilling the user, if he shows capability.

As the gas conditions in America are radically different from those in Europe the development of the inverted lamp has been rather tedious. The inventor from the start recognized the great value to be derived by the gas company as well as the user should he succeed in perfecting his device.

To-day I consider the inverted light commercially perfected, and all that remains to revolutionize our present lighting systems is the careful education of the gas companies and dealers.

As before stated, the gas conditions in America are different from those in Europe, in that so many different processes of gas manufacture are in use, producing gases of varying candle-power, calorific value and gravity, and maintained under varying pressures. Each one of these conditions had to be very carefully considered in producing a burner which would be universally satisfactory.

If you should take an ordinary laboratory Bunsen tube and attempt to burn it in an inverted position, the chances are that you will experience great difficulty in making it burn properly, the tendency being for the flame to flash or fire back to the gas orifice in the base of the burner. This is not surprising when we consider that illuminating gas is lighter than air, with a consequent tendency to act as a counterforce to the down flowing mixture. For this reason a specially designed Bunsen tube was produced after experimenting on the different conditions above mentioned in various parts of the country, and while this tube, or raceway, entrained sufficient air to produce a most excellent Bunsen flame, it did not overcome the difficulty of flashing back on lighting the burner.

Flashing back on the upright burners is prevented by the introduction of gauzes in the Bunsen tube as well as the burner cap. It was found, however, that the introduction of a gauze in an inverted burner was extremely detrimental to its working, particularly on low pressure, although it did effectively overcome the objectionable flashing back on lighting when the burner entrains more air than when after it is heated or during its normal burning, but it was the aim of the inventor to eliminate the gauze which he knew acted as an impedance to the flow, which when coupled with the counter force produced by the lighter gas, caused carbonization, and also which he knew would collect or strain any dust which might be in the air entrained by the burner.

There is another way of preventing the flashing back on lighting, and that is to close partially the air-shutter at the base of the Bunsen tube, but as the flame of the Bunsen changes, due to its inability to

entrain as much air after being heated as when cold, it is obviously imperative that the air-shutter should be open, and the burner entrain as much air as possible.

To obtain ideal working conditions, therefore, it would seem necessary either to insert a gauze on lighting the burner and afterward remove it when the burner became hot, or to partially close the air-shutter on lighting and afterward open it.

This very result has been accomplished in an extremely simple manner, A strip of thermostatical metal is stamped in somewhat the form of a comb, it is then wrapped over a conical form, producing a split cone. It is inserted in the mixing tube of the burner, Fig. 1, and in this form performs the function of a gauze in that the mixture is compelled to pass through the narrow slits between the fingers, they being equivalent to the square mesh of the gauze. This is its form when the burner is first lighted; when the burner becomes heated, however, the narrow fingers straighten out and lie snugly against the inner surface of the mixing chamber, giving a free and unobstructed passage in the tube with nothing to catch the particles of dust or lint, and at the same time compensating for the counter action caused by the heating of the Bunsen tube. At this point, I should like to state that the accumulation of dust in an incandescent gas burner has caused more trouble and been responsible for more unfavorable criticism than any other one thing, as there are thousands of mantles in use giving indifferent illumination, due simply to the fact that they are being used on dirty burners. I have even known engineers to conduct endurance tests on a particular mantle without ever thinking of cleaning out the burner during the test, and the results obtained would appear to show an unusual deterioration, and so I repeat that the use of a thermostatic initial impedance in the place of the troublesome gauze will revolutionize gas lighting, not only by increasing the lighting efficiency, but also by the elimination of that most troublesome feature—dust. It is needless to say that when the light is extinguished and the Bunsen tube cooled, the thermostat returns to its original position.

In attaching the mantle to the burner tip, it was found that the most convenient method was a bayonet lock, as this did not necessitate a close fit, which it is practically impossible to obtain with the materials used. The tip of the burner, which is subject to an extremely high temperature, in fact, a bright, cherry heat, had to be made of some infusible substance, the most suitable proving to be a magnesia clay, and it is obvious that the mantle ring must be made of the same substance. Metal tips have been used, but it has been found they quickly oxidize, scales dropping into the mantle and globe. Furthermore, the burnt growth on the inside of the tip clogs it, causing the burner to carbonize. Another problem to overcome was the discoloration of the fixture on which the burner was attached, due to the fact that the products of combustion were not properly diverted. The burner was so constructed as to send the products off to one side by means of heat deflectors over the crown vents, as shown in the cross-section cut, Fig. 1. Another advantage in deflecting the products of combustion off to one of the burners is, that a fresh air supply for the Bunsen is at all times ensured.

The inverted mantle does not necessarily have to be removed from the tube before mounting on the burner as does the upright mantle. It is simply necessary to

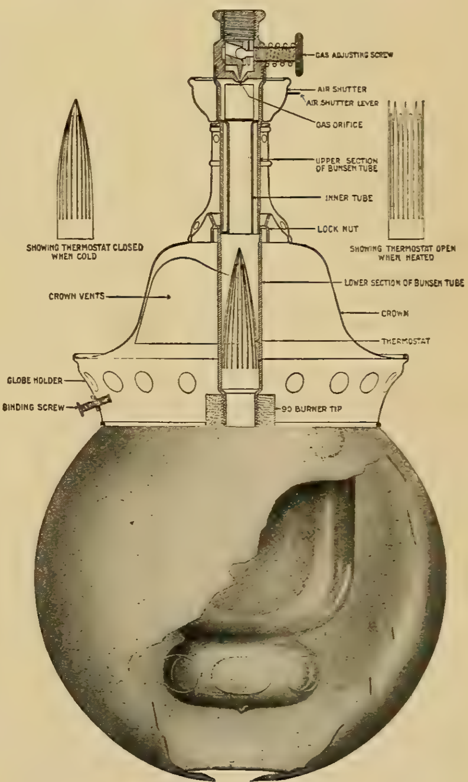


FIG. 1.—CROSS-SECTION OF REFLEX BURNER.

remove the lid and raise the mantle and tube over the burner tip, turn and lock-in the bayonet and remove the tube, leaving the mantle in position on the burner. The question naturally arises why an inverted gas light is more efficient than an upright light. By referring to Fig. 2 you will note

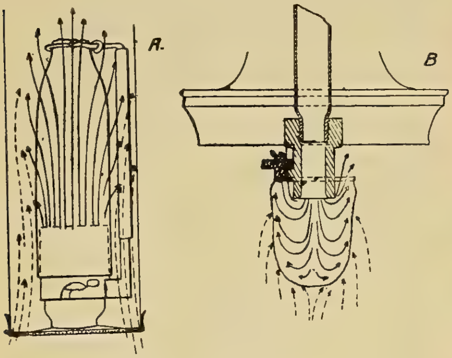


FIG. 2.—DIAGRAM SHOWING CIRCULATION OF AIR AROUND BURNERS.

the arrows indicating the flame paths and products of combustion; other arrows surmounting lines indicate the passage of the air currents around the mantle. Section A represents the currents in the upright mantle. The products of combustion are compelled to pass through the mantle, preventing the oxygen from the surrounding atmosphere from coming into intimate contact with the surface; whereas, in Section B you will note that the flame is baffled by the mantle so as to send the products out between the burner tip and the mantle ring, allowing free access for the oxygen and surrounding atmosphere to almost the entire surface of the mantle, thus ensuring a more perfect combustion at the surface, resulting in a much higher incandescence. Working under similar conditions, therefore, the inverted mantle will always burn with a greater intensity than the upright mantle for the reason above mentioned, and it has been demonstrated the higher the incandescence of a mantle, the more efficient the light, it being understood, of course, that the burner equipment remains the same.

As I have stated on several occasions, the mellow light mantle is in every way superior to a mantle giving a ghastly white light, and this is particularly the case with the inverted light, for the mellow light mantle is at its best when raised to a very high incandescence. The one great superiority of the inverted mantle over the upright is its additional strength. The method of attaching to the holding ring is more favorable and the dome-like shape of the mantle and its uniform suspension is also superior. The inverted mantle has a smaller mass, consequently a lesser strain at the point of attachment. To bear out this statement, I might mention that inverted mantles have been in use in this country in railway trains for about two years, and several thousand coaches are now so equipped, giving the greatest satisfaction. They are used with Pintsch gas, which has a calorific value of about 1,400 B. t. u., the pressure being one pound. Fig. 3 shows the application of the inverted lamp to car lighting. The inverted burner consumes about 33⅓ per cent. less gas than the best upright burner, at the same time giving much more useful light. It is particularly adapted to reflection, as will be noted from the candle-power curves shown in Fig. 4.

FIG. 3.—RAILWAY CAR LIGHTING BY INVERTED MANTLES.

The Application of the Inverted Lamp.—Indirect lighting is acknowledged ideal, but it is quite expensive and usually difficult of application. The next best is direct lighting with the source obscured, an example of which is given in Fig. 5. The angle shown is extremely useful in lighting desks, store windows, work benches, bowling alleys, etc. This reflector has been referred to in connection with a public hall or meeting room lighting scheme, on which I recently read a paper before the Philadelphia Section of the Illuminating Engineering Society.

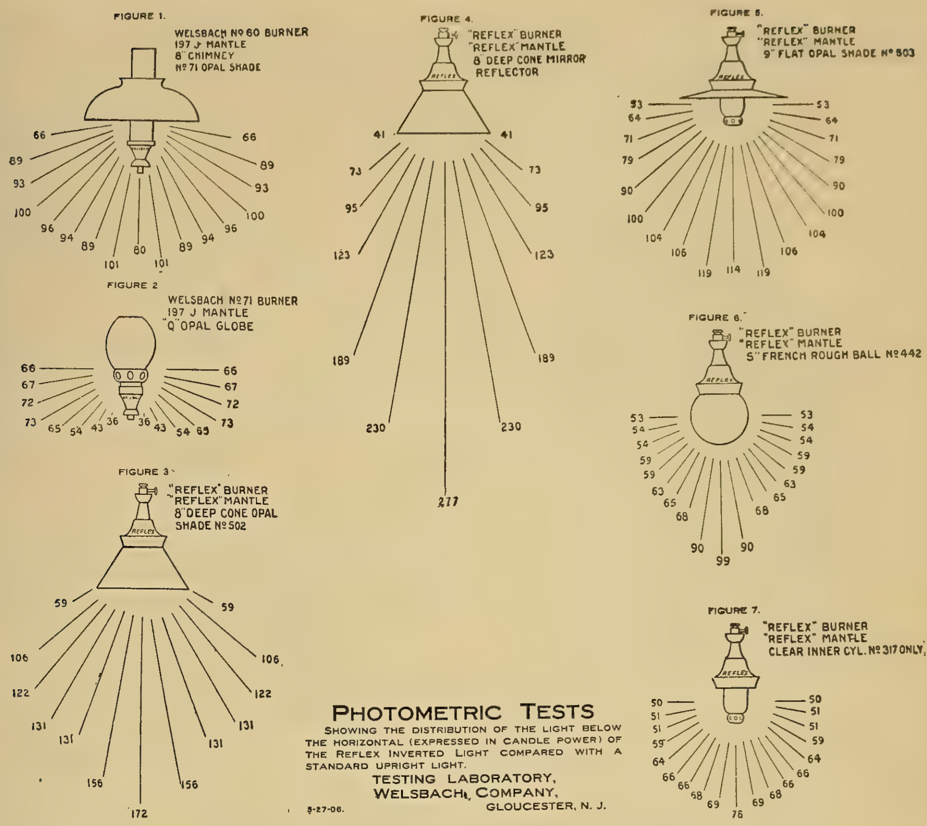


FIG. 4.—CANDLE-POWER CURVES OF MANTLE BURNERS.

Lighting by electricity has received a great impetus in the last couple of years by the scientific application of prismatic glass reflectors, and while the same cannot be said of gas lighting in connection with the upright mantle, it will be true in the case of the inverted light. A simple scheme for holding a Pagoda shade has been devised which, by proper installation, keeps the shade cool enough at all times to be handled. A concentrating Pagoda reflector, as shown in Fig. 6, is extremely useful in store window lighting, etc., and incidentally shows the great lighting efficiency and economy to be obtained from the use of three cubic feet of gas, which at the prevailing average rate of $1.00 per thousand cubic feet throughout the country would cost .3 of one cent per hour.

You will note that directly below this lamp 314 candles is obtained, with a fairly good distribution to within 60 degrees of the horizontal. The application of the inverted burner to residential lighting is particularly effective. In my home I use an arc glass dome with a "Reflex" lamp equipped with a Pagoda prism glass reflector. The mantle is so high in the dome as to be completely obscured from those sitting around the table, and the lighting of the table is perfect. The room in this case is lighted indirectly by the reflected light from the table-cloth. It might be supposed that there would be an objectionable glare from the cloth, but such is not the case. As the useful light (mean lower hemispherical candle-power) is much greater than with the upright type of burner, it is particularly adapted to residence lighting.

COMMERCIAL LIGHTING.

Window Lighting.—Either one or two methods may be employed. In small windows one or two burners equipped with the angle reflector, as shown in Fig. 5, might be used, Fig. 7 showing the candle-power so obtained.

In large windows a row of these burners

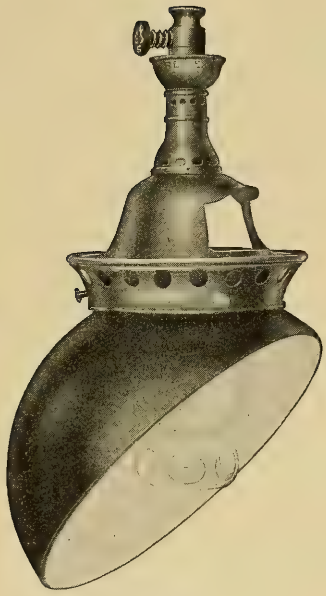


FIG. 5.—REFLEX LAMP.

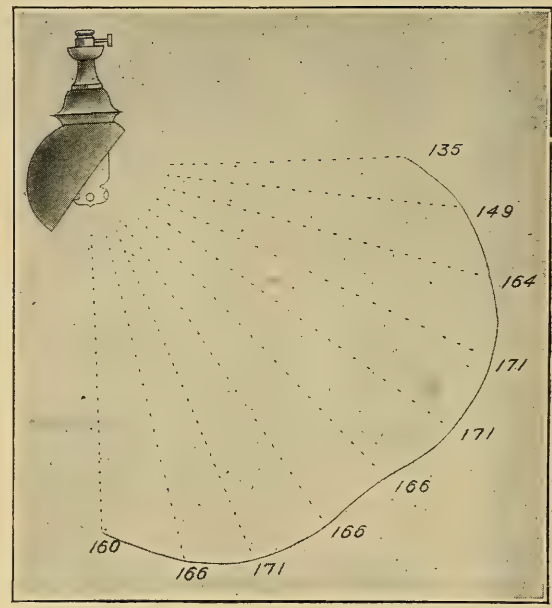


FIG. 7.—CANDLE-POWER CURVE OF ANGLE SHADE.

may be arranged high and to the front, and equipped with jump-spark electric ignition so that they may be lighted from a distance, and the piping so arranged as to be automatically extinguished by clock work. Several installations of this kind are being successfully used in the larger cities.

Another successful means of lighting store windows is to arrange the burners with the proper reflectors immediately above a deck of frosted glass. This allows the window to be completely sealed and does not make it necessary to enter the windows to trim the lamps. The lamps may be lighted from a distance as before mentioned.

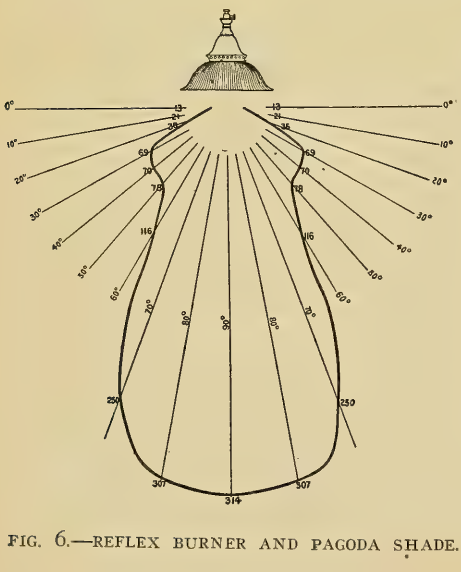


FIG. 6.—REFLEX BURNER AND PAGODA SHADE.

Great progress has been made in Philadelphia and several other of the larger cities in shop and factory lighting. The inverted light seems to be particularly adapted to this kind of work, and, as the mantle is very much stronger than the upright mantles, it will stand almost unlimited vibration, particularly when suspended on flexible metallic tubing. (See Fig. 8, showing burner attached to the end of a flexible metallic gas-tight tubing.) This tubing is made by spirally winding a knurled steel ribbon, at the same time enclosing an asbestos cord to make the joint. As there is no rubber used in the construction of this tube it remains gas tight indefinitely, and should the burner be inadvertently struck, the burner would sway to one side, not damaging the mantle. This also enables the operator of a machine to shift the light to the most advantageous position.

I have attempted to cover the more desirable features of the inverted gas light, with some few samples of its application.

FIG. 8.—INVERTED MANTLE ON FLEXIBLE TUBING.

I do not hesitate to say that in the near future this system will be universally adopted.

Schoolhouse Illumination

By B. B. Hatch.

Paper read before the New England Section, June 18.

In presenting this paper on schoolhouse illumination, the author wishes to state that what is herein contained is intended only as an outline of the principal requirements of schoolhouse illumination as at present understood and a description of some of the present methods and the objectionable features encountered in their use.

As to the requirements: The schoolhouse department of the city of Boston, on its organization in 1901, very promptly took steps to improve both the natural and artificial illumination of school rooms, and after some experimental work, decided that artificial illumination, by what I shall designate as the indirect method, was most satisfactory and proceeded to install this system in all the new buildings and in such old ones as it became necessary to renovate. Comparatively few complaints were received at first, due probably in part to the fact that none of the new buildings were used for evening sessions, and in part to a desire to give the system a fair trial. Of late, however, complaints have been numerous and undoubtedly justified for reasons which I will give a little later. It is at this point that the author's connection with the matter begins, and quite naturally the first efforts have been directed toward the establishment of a definite standard of illumination or some definite agreement with the school authorities as to the exact requirements.

It might be added that this has so far been a most difficult question to solve, on account of the diversity of opinion among those most interested, practically all being agreed that none of the present systems is ideal, although the old form of open cluster seems to have the most friends.

It is the author's opinion, however, that the requirements of class-room illumination may be stated briefly as such an arrangement of light sources that every desk will receive an illumination well defined as to direction, which should be from the left, yet so diffused that there will be no strong shadows, the minor shadows, of which there are bound to be some, to fall to the right of and below any opaque object, such as a pencil or book held in the hand on a plane with the top of the desk. How near we can come to an actual realization of these conditions remains to be determined, but experiments are now being made along this line, the results of which will be reported later.

There is one very important factor entering into this proposition, and that is the factor of reflection from the sidewalls. We meet with two difficulties here, one of which is easily overcome, while the other presents a very difficult problem.

The first difficulty is in the tinting of the side walls. As an illustration, we have had during the past winter, many complaints from a certain schoolhouse where the side walls have recently been painted a very dark green, while the woodwork is stained Flemish oak, which is practically black, and this is in addition to the blackboards which extend to a height of about six feet above the floor on three sides of the room. The ceilings are cream white and the form of illumination is five three-lamp open clusters with eighteen-inch flat opal shades. This form of illumination

the application of the dark green paint was considered satisfactory to the school authorities. One or two rooms still remain with the old color—which is buff—and are not objected to. In contrast with this building we have another where the walls have been recently tinted a very light green, and this room with six indirect clusters, each having lamps of 48 aggregate candle-power is much more satisfactory than the one with open clusters first referred to. Other rooms in the same building painted several shades darker and having the same illumination, have been frequently complained of. Another new building, with dark walls and indirect lighting, is a constant source of complaint.

In speaking of the treatment of the side walls, mention has been made of the treatment of three walls. We now come to the fourth or window side of the wall and our greatest difficulty. The schoolhouse department requires that daylight illumination shall be provided in the proportion of one square foot of window to every five square feet of floor area, the head of the window being square and close to the ceiling. This uses up practically all of the side wall on this side of the room, leaving only the window-shades from which to obtain any benefit in reflecting artificial light.

As the windows are invariably on the left-hand side, you will readily see our predicament. It may be asked why not make the window shades of light colored material, and have them drawn whenever the artificial lighting is used. This can be done in the new buildings where all the air for ventilation is admitted by modern methods, but it is impractical in most of the old buildings where the windows must be opened to admit air. It is also a fact that it is impractical to depend on having the shades drawn. Some teachers will do it, but many will not.

This matter of side wall coloring not only has a direct bearing on the candle-foot illumination and direction of the shadows at the desk, but has a very bad physical or optical effect on the students, many of whom have been obliged to leave the evening schools on account of eye troubles which opticians ascribe to the bad color effects. These complaints have been most numerous from the building first referred to and have resulted in the appointment by the school committee of a commission of five members, three of whom are opticians and two electricians, to investigate and report on the best methods of illumination, both natural and artificial.

There is reason to believe that the findings of this commission will be of great assistance to us. At any rate, it cannot fail to bring us nearer to something definite in the way of a standard requirement, which is, after all, the keynote of the whole situation.

For the information of those who are not familiar with schoolhouse work, I will state that a standard primary class room has up to the present been 24 feet by 30 feet, or 720 square feet total area. A grammar school room 26 feet by 32 feet, or 832 square feet. All rooms thirteen feet in clear height.

The school committee has recently reduced the number of pupils to the room and in the buildings hereafter erected, the class rooms will be two or three feet smaller each way on the floor and about twelve feet six inches in the clear.

Since 1891 practically all class rooms have been lighted by the indirect method. Prior to that time, open clusters were in use. As so much has been said pro and con regarding this fixture, a description may be of interest. It consists of an under shade of opal glass, eighteen inches in diameter by six inches in depth. Inside this shade are four incandescent lamps, set in porcelain sockets, at an angle of about thirty degrees from the horizontal. A cover plate of clear plate glass resting in a spun metal ring, attached to the outer edge of the opal shade serves to exclude dust from the lamps and the inside of the opal under shade. Ventilation is provided by several holes in a small canopy surrounding the stem of the fixture near the glass cover.

This fixture is designed to project a greater part of the light against the ceiling and side walls, from whence it is thrown toward the floor in the form of diffused light, the direct light from the opal under shade being of some assistance to the illumination, yet not of sufficient intensity as to be disagreeable to the eye. Six of these fixtures, each equipped with lamps of 48 aggregate candle-power have been found capable of giving a standard grammar school room a very fair illumination, provided the side walls were correctly tinted and the fixtures in proper condition. To the casual observer, on first entering one of these rooms, the impression is given that there is not enough light, but one soon becomes accustomed to it and usually forms

a better opinion of the system on more extended acquaintance.

However, while it has been proved that this fixture is capable of excellent results under proper conditions, it has been found practically worthless on account of the difficulty of realizing these conditions, the difficulty being to keep the fixtures, ceilings and side walls in the condition to get the best results. In most cases where complaint has been made, we have found the cover glasses thickly covered with dust. The cleaning of these glasses was in turn found to be a much more serious matter than at first anticipated from the fact that the glasses seldom fit closely into the supporting rings, consequently dust works into the under shade whenever the glass is cleaned. This necessitates cleaning out the under shade with a damp cloth, an awkward operation, requiring considerable time. Having this feature in mind, the janitors are naturally reluctant to use the special duster provided for the purpose, and the illumination suffers accordingly. Some thought has been given to the idea of making this fixture dust tight, but the idea has been abandoned on account of other difficulties. I have found this fixture very useful in hospitals, having had several in use for over a year.

In January of the present year, we made a few experiments with different types of illuminants as a sort of preliminary step or guide in the selection of a type for further investigation. The results obtained were as follows:

1. Four No. 66 B. Welsbach gas burners consuming five cubic feet of gas each, and partially enclosed in an opal shade so that the light was partially direct and partially indirect.

2. Four, four-ampere alternating arc lamps with concentric diffusing shades and opal lower shades; total energy 1,760 watts.

3. Two, 275-watt, Cooper-Hewitt mercury vapor lamps without shades or reflectors.

4. Four, four-glower Nernst lamps with eight-inch alabaster ball shades. Lamps burned in upright or inverted position; total energy 1,408 watts, or 86 watts per glower.

5. Four standard indirect schoolhouse clusters equipped with four sixteen candle-power lamps each; total energy 800 watts.

6. Four ordinary open clusters equipped with four sixteen candle-power lamps each, and flat porcelain shades; total energy 800 watts.

7. Six standard indirect schoolhouse clusters equipped with four eight candle-power lamps each; total energy 672 watts.

8. Six General Electric, 125-watt "Gem" lamps, each equipped with a Holophane deep bowl shade of prismatic glass; total energy 750 watts.

The illumination obtained on the desks in the various rooms of East Boston high-school was as follows:

Gas	1.7	candle-feet
Arcs	1.7	" "
Mercury-vapor	4. to ¾	candle-feet
Nernst	2.	" "
Standard Indirect cluster 16 candle-power	1.	" "
Open cluster, 16 candle-power	1.7	" "
Standard Indirect cluster, 8 candle power	.5	candle-feet
Gem, 125-watt	3.	" "

From the foregoing, it will be seen that the best results have been obtained from the Nernst and "Gem" lamps, and further experiments are now being carried on with these illuminants in conjunction with various types of fixtures and shades, the final outcome of which will be made known as soon as definitely arrived at.

Railway Car Lighting

By George C. Keech.

Paper read before Chicago Section, June 13.

The railroads of this country anticipate that they will be called upon by the Government to abandon the use of flaming illuminants in mail cars. As they are also anxious to prevent loss of life and property from fire, they have been experimenting with various kinds of electric car lighting.

There are three electric systems which are apparently equally successful. One, called the "head end system," consists of a steam or gasoline engine in the head baggage car direct connected to a 110-volt generator. Each car of the train is equipped with cable connectors, and 110-volt lamps are used throughout.

Another system known as the "axle lighting," consists of a storage battery with a total voltage of usually 30 or 60, which continuously feeds the lamps, and which is charged while the car is in motion, by a small generator connected to the car axle. Each car has its individual outfit.

The third is the straight storage battery system, the cells being charged at the end of the run.

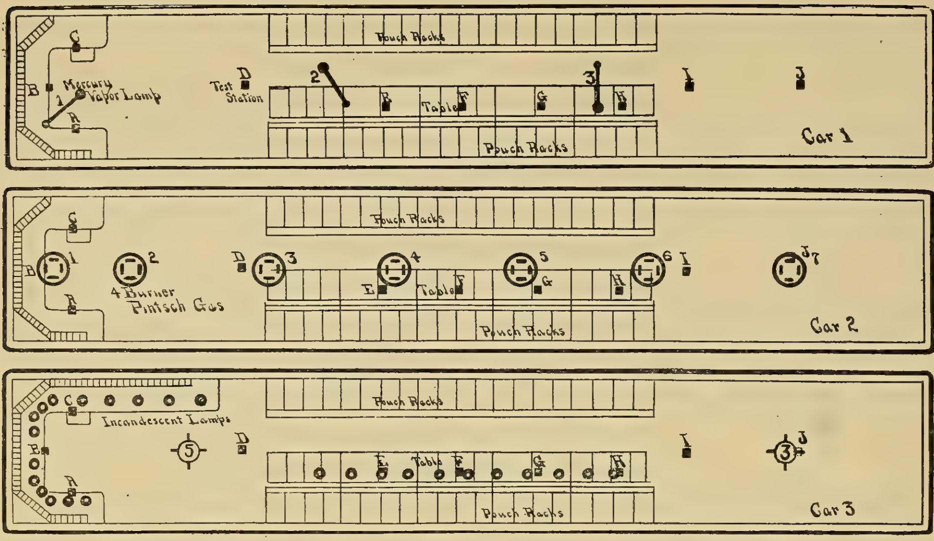


FIG. I.—FLOOR PLANS OF THREE MAIL CARS EACH WITH A DIFFERENT SYSTEM OF LIGHTING.

In all cases, but in the two latter especially, it is necessary to use lighting units of the highest possible efficiency.

The greater part of the work in mail cars is done at night, and, moreover, as the windows are few and small, artificial light is called for at all hours.

Fig. 1 shows the floor plans of three mail cars of the same dimensions and general arrangement, with a different system of lighting in each.

It will be noted that the letter sorting is done at one end of the car, where the benches and pigeon-holes are shown. The packages of letters and papers are placed on the tables in the middle of the car and thrown into the pouches hung in the racks as indicated. The other end of the car is used for storing pouches.

The lighting is arranged to suit conditions, and without regard to even distribution.

Letters A to J indicate test stations, the location being the same for each in the different cars and the height corresponding with the work done at the various points. For instance, stations A to C inclusive, were taken three feet nine inches from the floor, or the average height at which mail is held for reading addresses. Stations D, I and J are taken at one and one-half to two feet from the floor, where pouches are thrown in and out at the doors and tags are read. Stations E to H are three feet three inches from the floor, or the height of the distributing tables.

Fig. 2 shows cross-sections of cars, and the respective heights of the three different illuminants and of the test planes.

Car 2, in Fig. 1, is lighted by seven four-burner Pintsch gas lamps, hung in the middle of the car and arranged so as to have the greatest illumination at the distributing end.

Car 3 is lighted by thirty-one eight candle-power round bulb incandescent lamps, in white-lined, shallow-trough reflectors, operating on the axle lighting system. The single lamps cover the benches and tables, and one five-lamp and one three-lamp cluster are at opposite ends of the car, near the doors. These lamps average .7 ampere on 30 volts, or 21 watts each.

Cars thus equipped have been in service several years, and information which I have so far secured indicates that the operation cost per car-mile is less than that of gas, while the illumination, as will be seen, is 67 per cent. greater.

Car 1 is lighted by three type H mercury vapor lamps, of twenty-inch tube length, operating in multiple on the axle system, at 55 volts and 3½ amperes, or 192.5 watts each.

This car was put into service by the Chicago, Rock Island & Pacific Railway, at the suggestion of W. E. Ballentine, electrical engineer of the road, and at this writing has been in active operation for seventy-five days, at an average of twelve hours a day, or a total of 900 hours.

The vibration of the train has not affect-

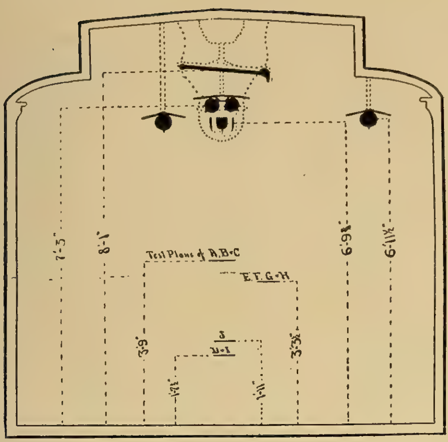


FIG. 2.—CROSS-SECTION OF MAIL CARS.

ed the lamps in the least and the tubes are apparently in as good condition as when started, and no trouble of any kind has been experienced.

The manufacturer's average life guarantee on the tubes will make the maintenance no greater than that of incandescent lamps, while the current demand is decreased, with a large increase in illumination.

In the case of axle charging, there is very little appreciable money-saving in the use of less current than in Car 3, but the liability of running down the voltage is lessened, preventing decreased brilliancy of lamps and sulphating of plates.

Fig. 3 shows illumination curves of the three systems, plotted according to the foot-candle readings at the different stations. As the test planes are of different heights, the variation is apparently great, but the curves are given as a matter of comparison only.

There is, of course, a greater variation throughout Car 1 than throughout the other two, on account of the size of the units and their distance apart on a comparatively low ceiling.

The vapor lamps in Car 1 are equipped with reflectors close to the tubes and as the ceiling and walls of the car are white, it is probable that the general effect would be improved by removing the reflectors. No test has, so far, been made on this arrangement.

Table I. shows the foot-candle readings on these cars.

As the reading of addresses on mail matter in a moving car for a number of hours at a time is quite a strain on the eyes of the postal clerks, it is not likely that an average of from eight to ten foot-candles and a maximum of fifteen is too much illumination.

The experience of the Washington, New York and Chicago post-offices with mercury vapor lamps has proved beyond a doubt that the quality of the light therefrom is of the very best for mail distribution.

TABLE I.

FOOT-CANDLE READINGS.

Stations.	Car 1. Mercury Vapor.	Car 2. Pintsch Gas.	Car 3. Incandescent Lamps.
A	15.0	1.33	2.5
B	17.5	1.7	4.6
C	7.5	1.42	4.4
D	4.6	1.1	1.5
E	11.3	1.79	1.48
F	4.0	1.15	2.2
G	9.1	1.65	2.17
H	14.5	1.43	1.85
I	4.1	.8	.68
J	.95	.89	.72
Average.....	8.85	1.32	2.21

The cost of operations of various systems, I am leaving to be taken up in the discussion of this paper by those who have had actual experience in watching these items:

PASSENGER COACH LIGHTING.

At the same time that the above tests on mail cars were being made, it was possible to obtain some interesting readings on passenger cars.

Fig. 5 shows the floor plans of two electrically lighted cars. Car 1 is lighted by three arc lamps, as indicated, these being operated at 100 volts by a battery of fifty cells, which is charged every other day.

This car leaves the Chicago & Northwestern station, at Chicago, every evening

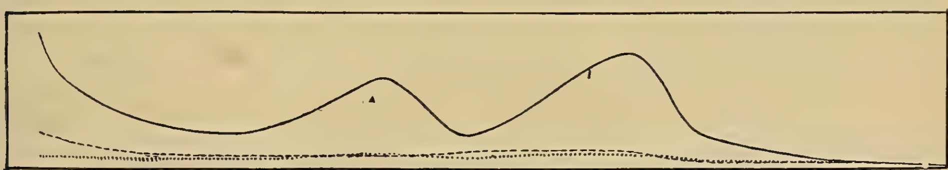


FIG. 3.—ILLUMINATION CURVES OF THREE SYSTEMS OF CAR LIGHTING.

TABLE II.

	Car 1. Mercury Vapor.	Car 2. Pintsch Gas.	Car 3. Incandescent Lamps.
Height of lamps........................	8′ 1″	7′ 3″	6′ 11½″
Height of test plane A, B and C..........	3′ 9″	3′ 9″	3′ 9″
" " " " E, F, G and H......	3′ 3½″	3′ 3½″	3′ 3½″
" " " " J	1′ 11″	1′ 11″	1′ 11″
" " " " D and I............	1′ 7½″	1′ 7½″	1′ 7½″
Number of lamps........................	3	7	31
Watts per lamp.........................	192.5		21
Watts per car...........................	576		651
Average foot-candles	8.85	1.32	2.21
Square feet illuminated..................	570	570	570
Watts per square foot....................	1.15		1.30
Foot-candles per watt per square foot.....	7.69		1.7

The results in Table II. show that the investment in batteries and apparatus would be very high, to secure the same illumination with incandescent lamps that is possible with vapor lamps, and, as stated above, the trial so far given the latter as to staying qualities, indicates that they will be eminently successful for this purpose.

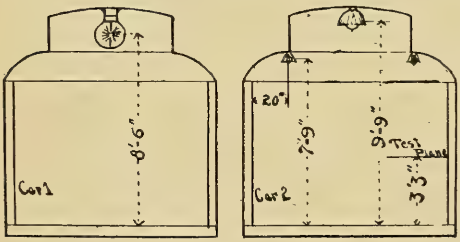


FIG. 4.—FLOOR PLANS OF TWO ELECTRICALLY LIGHTED CARS.

at 6.30, for Waukegan, Ill., the number of hours of lighting between charges being about ten. This car has now been in service for three months.

The test stations A to N were located three feet three inches from the floor, at the positions persons would naturally hold books or papers when riding two in a seat. The illumination was taken at an angle of 60 degrees from the horizontal. Stations O to V were three feet from the floor, on a horizontal plane, and taken for the purpose of showing the variation throughout the length of the car.

Car 2 is a reclining-chair car in service on the Chicago, Milwaukee & St. Paul Railway. The system is head-end lighting, and the body of the car contains fourteen eight-candle-power 110-volt, 30-watt, and four forty-candle-power metalized filament, 100-watt incandescent lamps.

Each eight-candle-power lamp in the

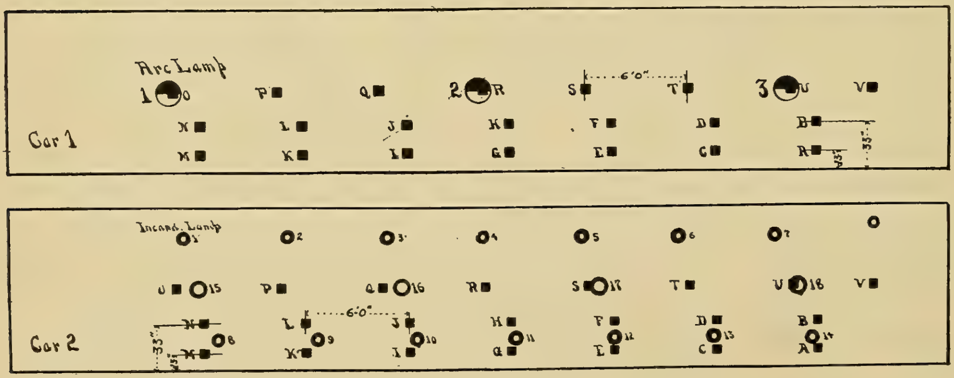


FIG. 5.—ELEVATIONS OF TWO ELECTRICALLY LIGHTED CARS.

Tables III. and IV.

FOOT-CANDLE READINGS.

Stations.	Car 1. Arc Lamps.	Car. 2. Incandescent Lamps.
A	1.50	1.2
B	1.86	1.15
C	.38	1.2
D	.43	1.25
E	.73	1.23
F	1.02	1.25
G	1.67	1.55
H	2.41	1.4
I	.35	1.7
J	.47	1.45
K	.95	1.9
L	.93	1.5
M	1.48	2.1
N	1.58	1.8
Average......	1.12	1.47

FOOT-CANDLE READINGS.

Stations.	Car 1. Arc Lamps.	Car 2. Incandescent Lamps.
O	2.16	1.2
P	.85	1.9
Q	1.55	1.65
R	3.25	1.7
S	1.41	1.8
T	1.25	1.5
U	2.90	1.85
V	1.17	1.05
Average	1.82	1.58
Highest reading ..	3.25	1.9
Lowest reading...	.85	1.05
Maximum variation	2.40	.85

lower deck is equipped with a No. 2623, and each forty-candle-power lamp in the upper deck with a No. 7330 Holophane reflector.

The tests were taken at the same locations, heights and angle as in Car 1.

Fig. 4 shows also a cross-section of each car, with height and lateral location of lamps.

Table III. gives the foot-candle readings taken in the car seats, and Table IV. those taken down the middle of the car.

Table V. gives the results and shows that the foot-candles per watt per square foot are very close together. The arc lamp car is the more economical, but the variation in illumination is much greater.

Fig. 6 is the floor plan of a section of a parlor car, the lighting of which consists of side brackets nine feet apart, with single frosted incandescent lamps of eight-candle-power, equipped with small porcelain shades, and down the center of the car, nine feet apart, are clusters of three eight-candle-power clear lamps under twelve-inch white porcelain bowl shades.

Four tests were made in this car at the stations indicated, to establish the illumination at reading positions in the respective chairs.

Fig. 7 is a floor plan of the observation room of the car Valdoria, also operating on the Chicago, Milwaukee & St. Paul Railway. The wall brackets contain two sixteen-candle-power clear lamps each, and the center fixtures are Pintsch gas lamps, surrounded by four sixteen-candle-power incandescent lamps. The tests were made with only the electric lamps burning, and were taken in reading positions. As the movable chairs would be in the indicated locations at most times that artificial light

Table V.

	Car 1. Arc Lamps.	Car 2. Incandescent Lamps.
Height of lamps (average)...............	8′ 6″	8′ 9″
Height of test plane A to N 60°..........	3′ 3″	3′ 3″
" " " " O to V horiz........	3′ 0″	3′ 0″
Number lamps	3	18
Watts per lamp........................	250	30 and 100
Watts per car..........................	750	820
Average foot-candles (entire car)........	1.28	1.50
Square feet illuminated..................	419.5	385.4
Watts per square foot....................	1.78	2.13
Foot-candles per watt per square foot.....	.719	.704

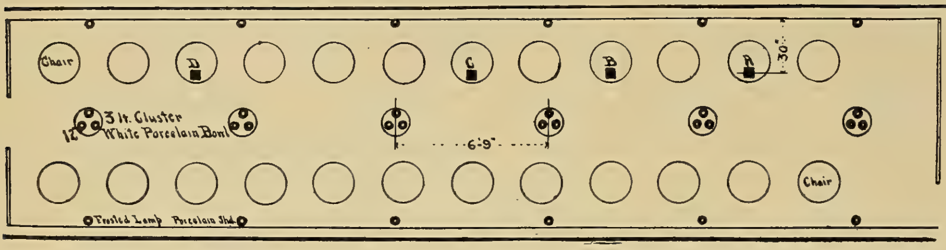


FIG. 6.—FLOOR PLAN OF AN ELECTRICALLY LIGHTED PARLOR CAR.

would be used, the readings at stations A, B, C, D, would be typical for the car.

Station E, in Fig. 7, was located on the writing desk, and the illumination was 4.9 foot-candles when the surface was shadowed by the person seated at the desk, and 5.7 foot-candles when unshadowed.

Table VI. gives the foot-candle readings in these last two cars, and Table VII. the results compared with those of Car 1 and Car 2 in Figs. 4 and 5.

TABLE VI.

FOOT-CANDLE READINGS.

Stations.	Parlor Car.	Observation Car.
A	1.65	2.75
B	1.55	3.25
C	1.45	3.50
D	2.00	4.10
Average......	1.66	3.40

It will be noted that, with a much higher wattage per square foot in the observation car, the foot-candles are not as high in proportion as in the other two incandescent lighted cars, leaving the foot-candles per watt per square foot much less.

Table VII. may be considered as a good comparison between the four cars as to the illumination for reading.

The writer is indebted to Mr. A. J. Farrelly, electrical engineer, of the Chicago & Northwestern Railway; Mr. W. E. Ballentine, electrical engineer of the Chicago, Rock Island & Pacific Railway; Mr. C. R. Gilman, electrical engineer of the Chicago, Milwaukee & St. Paul Railway, and Mr. A. C. Saxton, superintendent, Consolidated Railway Electric Lighting and Equipment Company, for much of the information contained in this paper, and for assistance in making the tests.

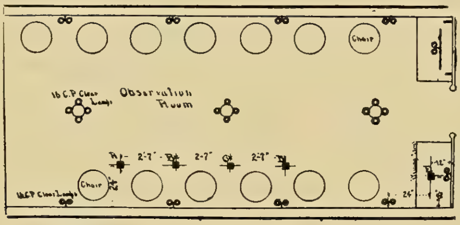


FIG. 7.—FLOOR PLAN OF OBSERVATION ROOM OF CAR.

TABLE VII.

	Car 1. Arc.	Car 2. Incandescent.	Parlor Car. Incandescent.	Observation Car. Incandescent.
Number of lamps......................	3	18	30	32
Watts per car........................	750	820	900	1664
Average foot-candles (Table 3)...........	1.12	1.47	1.66	3.4
Square feet illuminated..................	419.5	385.4	371	199.5
Watts per square foot....................	1.78	2.13	2.42	.34
Foot-candles per watt per square foot....	.629	.69	.644	.407

Color Values of Artificial Illuminants

By Bassett Jones, Jr.

Communicated discussion of the paper read by G. H. Stickney before the New York Section.

The remarks made by Mr. G. L. Hunter seem to me not only to be very much to the point, but, in addition, absolutely borne out in the general practice of illumination. The greatest difficulty that the illuminating engineer will have to contend with is the fact that in the practice of his profession he must be quite as much an artist as he is a scientist.

It is never sufficient to light a room economically and adequately. It is also necessary to light it artistically. And the lighting is never merely a matter of light sources and their position only. It is also a matter of decoration, color schemes, design of fixtures and arrangement of shadows. I have purposely made this statement general so as to include all interior lighting, for there is no more excuse for making a barbaric, soul-shocking hole out of a workshop than is the case with a theater foyer. It is only a matter of degree. The simplest and barest interior may be made effective by the use of a little common sense.

The laws of nature are, at heart, the laws of art; and provided nature is given half a chance, she can do the most wonderful things with even so ephemeral a thing as a ray of light. How few years have passed since nothing could be made more hideous than a fixture shade! Think of the horrible, rickety, distorted, and staring forms that ruined many a soft, pleasing interior! Then turn to the similar product of to-day. Could anything be more effective in its simplicity and gentle curves than the prismatic reflector when designed properly to distribute and diffuse the rays from a light source? Give nature a chance, and your product can never fail to be artistic and happy in its lines.

Even so prosaic a thing as a simple truss can be made pleasant to look at, if the stress members do really follow the lines of stress and are not made to take a short cut through some false idea of economy. The economy of the hideous is never a real saving. And this applies equally to a lighting fixture as to a façade.

A fixture is meant to support lamps. Then, make it evident. The law of architecture, that no matter how rich the decoration the lines of structure must never be hidden, should equally govern the design of a cathedral and the design of the simplest bracket. And yet another rule of equal moment: add no decoration that is unnecessary, and that does not serve to accentuate the meaning and purpose of the structure.

The line of force is the "motif"—the fundamental idea. The decoration is the harmony that makes the motif stand forth in accentuated brilliance. There is no other use or purpose for ornament, and this is its sufficient reason.

And now recall those inverted wash-tubs that Mr. Stickney showed us plastered on the ceiling of several unfortunate stores. There is absolutely no excuse for such lack of harmony in proportion. The fundamental conception is good. The properly designed curves of the diffusing surfaces are attractive and pleasing. But why not carry out the idea—why this villainous stucco of senseless and badly done ornament? I speak strongly, but the subject calls for strong language. You cannot expect to sell such devices for use in locations where beauty is of any moment. The rising tide of artistic appreciation in this country will quickly discountenance any such violation of the laws of design.

Think, too, of the arc-lamp casings we are compelled to put up with. The only standard design that is in any way possible is the plainest, for the simple reason that it lacks any arrangement of ineffective and ill-proportioned mouldings.

Another point which both Mr. Hunter and Dr. Seabrooke brought to our attention—the fact that direct white light is not the light suited to our eyes. Indeed, Nature has so constructed us that the eye is effectually shaded from any but accidental white light. We see almost entirely by reflected light, and this is never white; blue, red or yellow, or some combination of these three primary colors, are the predominating shades, while white light causes a more or less aggravated sense of dazzling. When the sun is low enough to shine directly into the eye, its color is toned down to a predominating yellow.

The natural outcome would seem to be that the walls of a room should never be white unless the light is of a yellow or green tint, and that if a white light source is used then the decorations should be generally green, yellow, or some tint in which yellow is the predominating shade.

Brilliancy and color produce entirely dif-

ferent physiological effects. At great brilliancy, as Mr. Stickney showed, the sense of color is lost. An intense green, red or yellow light produce practically the same sense of white light. The arc crater, producing red, yellow, or blue light, if exposed directly to the eye produces a point of almost pure, dazzling white, and all three are equally dangerous. The general craze for lamps of high intrinsic brilliancy cannot fail, in the long run, to produce deterioration of the eyesight. It is purely a matter of habit, and we are gradually and imperceptibly increasing the power and number of our light sources to the danger point. We hear, nowadays, of illumination running up to three, four, and even five candle-feet, on the assumption that since the far greater brilliancy of the sun's light produces no appreciable injury, an equivalent brilliancy in artificial illumination will be equally beneficial. But this argument loses sight of the very great difference between the direction, diffusion and quality of the light from the two sources. Imagine, if you can, an artificial illuminant that gives the equivalent of midday sunlight in a room without the great height of the light source, resting distances, softness of reflected light, and general tone that makes the open noon so pleasant to behold. If not absolutely blinding, the result would be hideous beyond conception.

And now take Helmholtz's dictum, an experiment we all can readily try. How pleasant the result! And particularly after an hour spent under the sun in the zenith, the eye will feel rested and we realize that the organ was not and could not be built for maximum conditions. Bright noon does not show the eye at its best. Rather is it under normal conditions when the day is waning and the sun's rays, no longer white, but filtered to a soft yellow, throw the deepening oases of shadow across the landscape. Here, then, is to be found the goal that our artificial illumination should seek to secure.

One other point that is of vital importance in designing the artificial illumination of an interior is that most rooms are illuminated for the major portion of the time they are in use by the light that filters in through the windows. The result is, that unless due care is taken properly to qualify the artificial illuminants, the entire decorative scheme of the room may be ruined. Interiors, such as theaters and auditoriums, used only at night, usually do not require any consideration of the difference in color, quality, and direction of daylight and the light from artificial sources. But in the majority of cases the interior is designed to give its best effect by daylight, and it requires great care in selecting and arranging the artificial light sources to accent properly the salient features of design at night. In fact, it is very generally the case that arrangement of the light sources and the direction of the light is of far greater importance than the candle-feet or the diffusion.

The two features of artificial illumination that must be thoroughly mastered by the illuminating engineer are, then, color effect, and fixture design. And these are the two most difficult problems that he has to face. His entire work may be set at naught unless he can control them, and he cannot hope to make his work right until he shows himself thoroughly appreciative of their value.

New Lights and New Illuminants From the Central Station Point of View

By R. S. Hale.

The new illuminants are devised by engineers and inventors, and are a great advance in the art of lighting.

The public in the form of customers of the central station uses the new illuminant and gets the advantage.

The central station is the intermediary between the inventor and the customer. From most points of view the central station makes and sells electricity rather than light, and if the central station produces and sells its product purely as electricity, then although the result might be important, yet the question of the method of handling the introduction of new illuminants would be of comparatively slight importance to the central station, or rather the central station has but little to do with it. When the central station is concerned with electricity only, it looks forward either to having the new illuminants give so much more light that they may cut down the total output of electricity, or, on the other hand, that the new illuminants may so increase the demand for light that the total output of electricity will increase; and if the central station is supplying only electricity, and taking no consideration of how it is used—in other words, if the central station pursues a policy of making no lamp renewals whatsoever —then, while the central station is interested

in the result, it can do but little more than to wait.

If, however, the central station is supplying lamps and including the cost of them in its charge for electricity—in other words, is selling light—then the new illuminant comes before the central station manager in a very immediate and practical way; and in the following notes I have given some of the essential factors that cannot be ignored, and some personal opinions which, however, I do not consider final. They are merely in the way the question strikes one at the moment.

In the first place the new illuminants are an improvement, and the word itself means that the new illuminants give a greater ratio between the light received by the customer and the current sold.

The immediate effect may be either that the central station sells the same number of units of electricity and the customer gets more light, or that the customer gets the same amount of light as before and purchases less electricity; and while the immediate effect must lie between these two points, yet the final result is effected by the increase in business, and may be such that even more units of electricity are used than ever before, and of course in such case, very much more light.

While it is possible that the new illuminants may permanently cut down the central station sales of current for light, yet this is very improbable. It is possible, for instance, that an improvement to say 50 candle power per watt would affect the central station lighting business, and would be as unpleasant to the central lighting stations as the railroads once were to the stage coaches. However, the final result will be the same whatever the central station does, and in my opinion the final result will actually be a very large increase of business. Any improvement in illuminants will bring in at least some competitive business. For instance, in Boston the sales of electricity amount to about three and one-half million dollars per year, and the sales of gas to about three million. Much of both of these is for power and heat, but even assuming that half of the gas sold is for lighting purposes, this leaves a possible competitive field open to the new illuminants amounting to one and one-half million dollars, besides the competition with oil lighting. This should mean an income for electricity of two to three million dollars a year, since customers will pay from 25 per cent to 100 per cent more for electricity than for gas, on account of the incidental advantage due to electricity, such as savings in decorations, wall papers, ventilation, etc.

In addition to the competitive field there are great latent possibilities. Many customers will pay $5.00 a month for a certain number of units of light. They will not pay $10.00 for double the number of units, but they will pay, say, $10.00 for triple or quadruple the number of units of light. Hence, while too great an improvement in illuminants may cut down the sales of electricity, there is an intermediate point where the improvement may actually increase the sales, and the improvements that are now apparently coming are, in my opinion, about this point. An improvement from one-third of a candle per watt to one candle per watt, such as is now in sight, will, in my opinion, ultimately increase the sales of electricity, and it will not be until we get to three or four candles per watt that the improvements in illuminants will cut down the sales of electricity.

In any case the final result will be the same, whatever the central station does, and the central station should not attempt to interfere with the final result any more than the hackmen of the city should be allowed to force the railroads to have several stations instead of a union station.

Although the final result will be the same, whatever the central station does, yet the immediate result to the central station that supplies free lamp renewals is a very important one.

If the central station is supplying free lamp renewals and adopts the new illuminants, the immediate effect will be to give the customers more light in proportion to the money they pay; and this may either cause an immediate fall in income followed, possibly, by an increase, or the central station may use its influence so that from the start the sales of current will remain the same or increase, while the light received by the customer shows a much greater increase.

This is the candle power question. To-day, or rather yesterday, the central station supplied a lamp giving sixteen candle power for 50 watts. If, on the introduction of the tungsten and tantalum lamps, they give sixteen candle power for 20 watts, the immediate effect would be a very considerable falling off in income, and the falling off in income would be very much greater than the falling off of expense, since every central station has a large amount of fixed expenses that is not affected by the immediate use of current.

If this were a free country and there were

no socialists, a central station might wisely risk the temporary loss in income, looking to its future profits to make up for the loss, but if in this country the central station pays no dividends for one or more years, this is seldom or never taken into consideration in the future when the question of reducing its prices comes in; hence the central station, or rather the people who have been frugal enough to save the money that built the central station, must plan to earn their dividend each year, and cannot risk losing it for even a short period.

Even without this consideration, if we assume that the future result of the new illuminants is to give the public much more light for the same or more electricity than at present, then the central station may properly attempt to reach this good result at once and instead of giving a sixteen candle power 20 watt lamp in place of its present lamps, it may offer its customers a 40 candle power 50 watt lamp at the start.

It is true that very often a 40 candle power 50 watt lamp will let a customer use two 40-candle power lamps where he now uses five sixteen candle power lamps, but the public is less apt to cut down its supply of current if the central station supplies lamps of the same wattage as before, and hence it is to the advantage of both the public and the central station that the first move in the adoption of the new illuminants should be in the direction of the lamps of the same wattage as now, and of much greater candle power.

Another important part of the central station view of the question is on the cost of renewals. If the cost of renewals is small in proportion to the total cost of electricity, then a slight variation in the cost of renewals is not important. For instance, to-day a central station, such as the Edison Electric Illuminating Company of Boston, supplies both eight and sixteen candle power lamps free. The cost of renewals of the eight candle power lamp is slightly more than of the sixteen candle power, but the difference is so slight that it can be disregarded.

One lamp company has just adopted the practice of so proportioning its lamps so that the renewal cost per kilowatt hour shall be the same for all sizes. Thus it supservice is reasonably large, it can be handled with fairly good satisfaction, but we have the immediate problem before us today, for instance, in regard to the Nernst lamps in our outlying districts. If a customer in a small town, such for instance as Dover or Belingham, wants one Nernst lamp or one arc lamp, we cannot very well afford to send a man out there especially to trim and maintain one lamp. Hence obviously it is not enough in the cases of the new illuminant to say that its cost of maintenance, or renewal cost, is small when it is done in quantities. It is necessary that the new illuminant of a special kind must be quickly adopted in large quantities if it is to be adopted by the central station.

Another question that affects the central station very closely is that of deliveries. Take for instance the "Gem" lamp. I should say that the central stations were very well satisfied to-day with this lamp and feel that its cost of renewal is such that they could replace the ordinary carbon with "Gems." But unfortunately the factories cannot stop making ordinary lamps and go into making "Gem" lamps in one or two months, or even one or two years. At first the output of these lamps was five per cent of the total, to-day it is something like 25 per cent, and it will be a year or two before it is 100 per cent. While the central station may properly differentiate between different classes of customers, it must not discriminate. The central station, just like the telephone company, or the water works, may make one price for commercial business and another price for residential business, but it must not differentiate between Brown and Smith whose business and use of current are alike. Hence, the question is, "Who shall get the 'Gem' lamps, and who shall use the carbon lamps during the period of transition?" This has been solved in part by making a temporary extra charge for the "Gem" lamps. For instance, the large companies to-day that formerly renewed ordinary lamps free, still continue this practice, and they also renew "Gem" lamps, making an extra charge of five cents only as compared with the cost of the lamp of fifteen cents and twenty cents.

Apparently something like ten per cent to twenty per cent of the customers are willing to pay this five cents extra charge. The others prefer to pay twenty per cent to thirty per cent more on the bill for electricity. Theoretically, of course, we could reduce the charge to four cents, three cents, and so on down until the extra charge for the lamps became so small that every customer would rather have them, but below five cents it is a question whether there would be much difference in the demand.

This question can also be handled in the same way that the New York, New Haven and Hartford Railroad reduced its fare to two cents a mile, by picking out different

divisions and saying frankly to everybody that they reduced the rate in one division, and that as quickly as it became possible to get out the schedules and do the clerical work, etc., the other divisions would likewise be benefited. This resulted in no trouble, as the customers of the railroad easily recognized the necessity.

In a similar way the central stations might pick out districts, or even classes of customers, and supply the "Gem" lamps free, say first to the churches, then say to municipal buildings, then say to residences, and so on until all customers were receiving them.

The "Hylo" lamp, while not in one sense a new illuminant, yet might properly be considered among them. The "Hylo" lamp saves the customer a great deal in places where he simply wants a dim light, but it costs the customer considerably more when he is using the full candle power. Hence a customer who wants a little light for a considerable number of hours, and a good light for a short number of hours, gets it very much cheaper by the use of the "Hylo" lamp. The customer who now keeps in darkness when he would like a dim light will get his dim light from the "Hylo," paying for that, and also paying an extra cost for the time when he wants a good light.

It is a question whether it would not be cheaper for the customer to put in two sockets side by side, one with a small one or two candle power light, and the other with an ordinary lamp of much better efficiency than the "Hylo." The extra cost of the second socket should not be over 75 cents or $1.00, for which fifteen or twenty cents a year would be a fair allowance, and it would certainly seem as though this would be cheaper than to have the extra cost of the "Hylo."

All the new reflectors, such as Holophanes, etc., are in a sense really new illuminants. They result in giving more light where it is needed, for the same amount of electricity, or the same light for a less amount of electricity; hence, a good reflector is just as good as an improvement in the efficiency of the lamp, and should have the same final result in the central station's businesss. In this case, however, it is somewhat simpler to have the customer supply plies, we will say, a 50 watt lamp whose proper life is 600 hours with a total consumption of thirty units, and if the cost of the lamp is fifteen cents, this makes the renewal cost one-half cent per unit. If the 100 watt lamp costs say twenty-five cents, it would then be so proportioned for voltage, etc., that during its economical life it would use 50 units. This practice is good, but unfortunately it does not cover the whole situation, since it is desirable that lighting circuits should be so arranged that small miscellaneous devices, such as cooking devices, fans, etc., should be supplied from the same sockets, and if the total cost of renewals becomes large in proportion to the cost of electricity, it is difficult to handle the question of free renewals.

The central station, therefore, much prefers that the new illuminants should be developed along the line of lamps whose renewal cost will be small in proportion to the cost of electricity. If, for instance, the price of electricity should get down to ten cents a unit on an average, and the renewal cost of the new illuminants should become four cents a unit, this would force the central station to give up the policy of free renewals.

This situation has actually arisen to-day in the case of very large wholesale customers. For very large wholesale customers burning long hours, as for instance a department store whose lamps are kept going all day, the cost of electricity gets down in the neighborhood of three or four cents a unit, and for such business the central stations are in general giving up the policy of free renewals. Even in the case of these large customers, however, the fact that they have to pay for the lamps in a separate charge has caused them to use lamps that are not as economical as they should be.

In the case of small customers, we have just had an instance in Boston here where we put out the tantalum lamps at a renewal charge that not only made the cost per unit of light much less than for the ordinary carbon lamp, but even made the cost for the 22 candle power tantalum lamp much less per hour than for the sixteen candle power carbon lamp. In spite of this fact we find that the customer objects very much more to paying an occasional 30 or 60 cents for a new lamp than he objects to paying 60 cents or $1.00 more every month on the bill.

The flaming arc is another good illustration of this feature. The flaming arc for outdoor lighting gives tremendously more light in proportion to the total cost and maintenance. The maintenance cost, however, is so great that the central station cannot possibly afford to include this in the price of current, so that the central stations have been forced to let the customer buy and maintain his own flaming arcs, and the

results have been that the customer would rather pay a much greater total amount in the form of a bill for current than to pay the two charges for current and maintenance and trimming, even if the total of the two was less than the charge for the ordinary arcs alone.

Another part of the question that affects the immediate interests of the central station, but which will finally cancel out, is the question of investment and antiquation. Take for instance the small carbon arc lamp using carbons of five-sixteenth inch diameter. This improves the light something like 25 per cent as compared with the arc lamp using one-half inch carbons, but its adoption would involve purchasing a full supply of new lamps (since the old lamps using a large carbon cannot be fitted over the small carbons). This would often be spoken of as involving scrapping of old lamps, but the correct point of view is from that of purchasing new lamps. Scrapping the old lamps is merely a book entry, while purchasing the new lamps takes the money out of the pockets of the people who have saved it up. If the small carbon lamps are going to be used for ten or fifteen years, then this will furnish time enough for the saving from them to make up for their cost; but if within two or three years the tungsten incandescent lamp is going to replace all our present arc lamps, then it is cheaper to wait for the tungsten than to purchase small carbon arc lamps and use them for two years only.

The Nernst lamp is to-day in much the same situation as the small carbon arc lamp. So far as we can tell, it is an improvement as compared with the ordinary incandescent lamp, but it costs $40 a kilowatt, and the question is whether it will save enough in the next year or two to make up for its investment cost when the tungsten lamp is finally put into service.

Another feature that the central station has to consider very carefully in regard to these new illuminants is their great multiplicity. To-day, for instance, the Edison Electric Illuminating Company of Boston, supplies, either free or at a nominal cost, over thirty kinds of incandescent lamps, six or eight kinds of arc lamps, and six or eight kinds of Nernst lamps. When the supply of any particular kind of renewal the reflector, and this has resulted in the kind of difficulties that the central stations are having from the new light being handled by the customer so far as reflectors are concerned. If the central station had in the past always supplied the reflectors to the lamps, then any improvements in the reflectors would have been just as difficult for the central station to handle as the tungsten, Nernst and other new lamps.

A very good summary of the difficulty that the central stations are having with the new illuminants is to call them growing pains. They are the difficulties that always arise when any new invention is made. If the customer supplies the lamps, as he does the reflectors, then the customer has the difficulties, and the central station waits for the final result, which may be either more business or less business. If, however, the central station supplies the lamps, it must handle the question so as to give as small a temporary loss of income as possible, and so as to get the final result from the new illuminant as quickly as possible.

The central station must also handle the transfer from an old illuminant to a new, so as to avoid as far as possible any unnecessary scrapping of machinery. The central station should not adopt an improvement that will result in only five per cent or ten per cent saving if at the end of a year or two it expects to find still another improvement has made the change of the year before a serious net loss on account of the very high depreciation.

The central station difficulties are what might be called detail questions, but it does not help us in handling these details to expatiate on the great future savings. Wise handling of the transfer by the central station will mean a considerable difference to the public, and this difference will be important, even if the savings by the new illuminants are much more important.

If any one doubts the wisdom of having a central station try to handle all these difficulties of illumination and lamps and candle power, etc., all that is necessary is to ask such person to look at the results in countries where the central station confines itself solely to the supply of electricity, and leaves the question of lamps and illumination to be handled by the individual customers.

PROCEEDINGS

Papers Read Before Technical Societies

DISCUSSION

The Phenomenon of Flame

Paper read before the British Association for the Advancement of Science.

By Prof. A. Smithells.

The topic of flame, after a long period of repose has aroused much interest during late years; and I think we may say that some considerable progress has been made in its elucidation, though in this, as in all other subjects of scientific inquiry, the more closely we scrutinize it the more impressed must we be with what still remains unknown.

One of the first questions to meet us in the study of flame is that of the temperature at which, in any given case, the phenomenon becomes evident. Here, I think, a great clarification of view has taken place. The old idea that there existed a fixed temperature at which inflammation suddenly took place cannot now be maintained, and the term "ignition temperature" has acquired a different meaning. It is now known that in a very great number of cases a mixture of two flame-forming gases, when gradually raised in temperature, will develop luminosity quite gradually *pari passu* with the chemical combination that is being induced. This phenomenon is, of course, known universally in connection with phosphorus; but it is not so widely known in connection with other combustible substances. I do not know how many times the independent discovery has been made that sulphur, arsenic, carbon disulphide, alcohol, ether, paraffin, and a whole host of other compounds, inorganic and organic, will phosphoresce as truly as phosphorus itself—that, in fact, phosphorescent combustion is the normal phenomenon antecedent to what we ordinarily call flame.

This is, after all, only in harmony with the general truth that chemical combination between two gases does not set in suddenly, but comes into evidence quite gradually as the temperature is raised from a point at which the action, if it occurs at all, is so slow as to be negligible. The change from phosphorescence to ordinary flame is not sudden, but the appearance of ordinary flame is the end-point of a continuous, though rapid, development. This end-point is the temperature of ignition. What, then, determines the temperature of ignition? The answer to this question has been given with characteristic conciseness by Van 't Hoff as "the temperature at which the initial loss of heat due to conduction, etc., is equal to the heat evolved in the same time by the chemical reaction."

Temperature of ignition is, then, neither a temperature at which combination suddenly begins, nor one dependent solely on the nature of the combining gases. It will vary with the proportion in which the gases are mixed and with their pressure and other circumstances. Notwithstanding the simplicity of this conception, it must be admitted that there are many obscure facts connected with the ignition of gases. The inflammability of gaseous mixtures is not necessarily greatest when they are mixed in the proportions theoretically required for complete combination. The influence of foreign gases does not appear to follow any simple law; the presence of a very small quantity of a foreign gas may exercise a profound influence on the ignition temperature as in the case of the addition of ethylene to hydrogen. When a mixture of methane and air is raised to its ignition temperature, a sensible interval (about 10 seconds) elapses before inflammation occurs. These facts are cognate to others which have increased upon us so abundantly in connection with the influence of moisture on chemical change.

The structure of flames has always been regarded as dependent upon the chemical

changes taking place in the differentiated regions; but until recent times little attention has been given to any questions beyond the cause of the bright luminosity of hydrocarbon flames. In a flame such as that of hydrogen or carbon monoxide, where we have some reason to suppose that the same kind of chemical transaction is taking place throughout the region of combustion, we should not expect to find a differentiation of structure; and, as a matter of fact, we do not find any. Erroneous ideas have gained currency from the use of impure gases; and hydrogen is still described as burning with a pale blue flame, although Stas long ago stated that if the gas is highly purified, and the air freed from dust, the flame, even in a dark room, can only be discovered by feeling for it—a fact consistent with the line spectrum of water lying wholly in the ultraviolet. The presence of a very small quantity of free oxygen in carbon monoxide destroys the perfect simplicity of the single shell of blue flame with which the purified gas burns; and in other flames small quantities of gaseous impurities or of atmospheric dust give rise to features of structure and halos which have been frequently supposed to pertain to the flame of the combining gases. The fringe of a flame in air may be often tinged by the presence of oxides of nitrogen.

No flame better illustrates the relation of structure to chemical processes than that of cyanogen, where the two steps in the oxidation of the carbon are clearly marked out in color. Apart from hydrocarbon flames, very few others have been carefully explored from this point of view. There is, unfortunately, no gas composed of two combustible gaseous elements; and, though such gases as the hydrites of phosphorus and sulphur do not fall far short of this, the experimental difficulties of an exact exploration of their flames are very great. We are thus prevented from studying the flame of a composite combustible in its simplest of forms.

The flames of hydrocarbons have naturally been the subject of most frequent investigation. The use of single hydrocarbons instead of the mixtures present in coal gas and other common combustibles has simplified the study considerably. Two problems stand out prominently. One is to trace the steps in the oxidation of the hydrocarbon; the other to account for the bright patch of yellow luminosity. With regard to the question of the luminosity, I do not think there is any longer doubt about its being due essentially to the separation within the flame of minute solid particles of what is practically carbon. The separation seems to be adequately explained by the high temperature of the blue burning walls of the flame, which decomposes the unburnt hydrocarbon within. In a similar way, arsenic and sulphur and phosphorus are liberated within flames of their hydrides; but these elements, being volatile, do not appear as solids unless a cold object be placed within the flame. In the case of the hydride of silicon, the liberated element at once oxidizes to form the solid non-volatile oxide, which gives a bright glow.

The mode in which a hydrocarbon yields carbon by the application of a high temperature has been the subject of experiment and of hypothesis. But neither the view of Berthelot, that the carbon results from a continual coalescence of hydrocarbon molecules with elimination of hydrogen, nor that of Lewes, according to which the formation and sudden decomposition of acetylene is the essence of the phenomenon, appears to me to be in harmony with the experimental facts; and I am not aware that either view has secured any support from other workers in this field. It is certainly not easy to ascertain experimentally the changes undergone by a single hydrocarbon as its temperature is raised; and at the last it may be objected that the course of events in contact with the solid walls of a containing vessel is not necessarily the same as that within the gaseous envelope of a flame. I am glad to think that there is promise of further light on this subject from the work of Professor Bone.

The course of oxidation of hydrocarbons has been the subject of very careful and fruitful study. The old view that a selective or preferential oxidation of the hydrogen always took place—that with a restricted supply of oxygen the hydrogen was oxidized and the carbon set free—is, I think, no longer maintained by anyone who has studied the question. The explosion of ethylene with its own volume of oxygen, which leaves us with practically all the carbon oxidized and all the hydrogen free, is fatal to this view. Again, when hydrocarbons are burnt in a flame with a restricted supply of air, as is the case in the inner cone of the flame of a well-aërated Bunsen burner, there is clearly no separation of solid carbon; and the prod-

ucts of combustion, when withdrawn and analyzed, disclose the presence of much free hydrogen and no unoxidized carbon.

The admirable researches carried out in the University of Manchester by Professor Bone and his collaborators, have afforded most valuable information as to the oxidation of hydrocarbons at temperatures extending from those of incipient oxidation up to the highest ones that prevail in a flame. According to Professor Bone, the oxidation of a hydrocarbon involves nothing in the nature of a selective or preferential oxidation of the carbon or the hydrogen; but it occurs in several well-defined stages, during which oxygen enters into, and is incorporated with, the hydrocarbon molecule, forming oxygenated intermediate products, among which are alcohols and aldehydes. The reaction, just referred to, between ethylene and an equal volume of oxygen is, according to Professor Bone, to be represented by the scheme:

$$\begin{array}{lllllllll} CH_2 & & CH.OH & & CH.OH & & H_2C:O & & H_2+CO \\ \vdots & \longrightarrow & \vdots & \longrightarrow & \vdots & \longrightarrow & & \longrightarrow & \\ CH_2 & & CH_2 & & CH.OH & & H_2C:O & & H_2+CO \end{array}$$

There can be no question about the facts on which this scheme is based, and they are a new and important addition to knowledge; but there are reasons that prevent me from acceptng entirely the interpretation which he has given to his experimental results. [Professor Smithells stated his reasons.]

The mode of burning of carbon, whether in the free state or as a constituent of a compound, is not at all easy to determine; and, notwithstanding many investigations, among which must be specially mentioned those of Professor Harold B. Dixon and his collaborators, so simple-looking a questin as whether carbon forms carbon monoxide by directly uniting with oxygen, or only by reducing carbon dioxide, is still a matter of uncertainty. Our knowledge concerning the question of flame temperatures has been much improved in recent times, thanks mainly to the admirable work of M. Le Chatelier. The well-known memoir of Mallard and Le Chatelier on the explosion of gases supplied the data which first permitted of a moderately exact calculation of flame temperatures; and the perfection of the thermo-couple by M. Le Chatelier gave us the first instrument that could be used directly for making a satisfactory measurement. The uncertainty connected with this subject may be well illustrated by quoting the temperatures that had at different times been ascribed to the flame of coal gas when consumed in a Bunsen burner, where we have had values from 1,230° to 2,350° C.

With regard to the use of thermo-couples, I may remark that the practical difficulties have been successfully met. The chief difficulty is, of course, to secure that the thermo-junction attains, as nearly as possible, the temperature of the region in which it is immersed. As ordinary flames consist of thin shells of burning gases, on either side of which there is a very rapid fall of temperature, it is necessary to use thin wires, and to dispose them so that there is no appreciable drain of heat from the junction. By using wires of different gauge for the couples, it is possible by extrapolation to arrive at a temperature for a couple of infinitely small cross section, and it is also possible to make a correction for the superior radiating power of the the couple as compared with flame-gases. Without this last correction, a maximum temperature of 1,770° C. was obtained for the Bunsen flame by Waggener in Germany, and 1,780° by White and Traver in America. Correcting for radiation, Berkenbusch found 1,830° as the maximum temperature. M. Féry, by an ingenious application of his beautiful optical pyrometer to a flame containing sodium, gives 1,871° as the highest temperature of the flame of a Bunsen burner burning coal gas.

The consideration of flame temperatures has become of increasing importance in the arts, owing to the use of the Welsbach mantle as a means of deriving light from coal gas. The great improvements which have been made in the efficiency of atmospheric burners depend primarily on the fact that the smaller the external surface we can give to a flame consuming gas at a fixed rate, the higher must be the average temperature; and since the emission of light from a mantle is proportional to a high power of the absolute temperature, a small increase of temperature is of great effect on luminosity. The acetylene-oxygen flame, in which a temperature of about 3,500° prevails—not very different from that of the electric arc—is the hottest of the hydrocarbon flames, and finds some important practical uses.

I have already said something about the luminosity of flames so far as relates to the separation and glow of solid carbon. But there remains the more general question of the luminosity of flames containing nothing but gases. The older explanation of the emission of light from combin-

ing gases said no more than that the energy liberated during the reaction and appearing as heat raised the product to incandescence—that is to say, so increased the velocity of its molecules and the violence of their collisions that vibrations were set up whose wave-lengths lay within the limits of visible radiation. This explanation has long been questioned; and there is now, I think, a very general agreement that it will not suffice. The average temperature, in fact, prevailing in a flame, if attained in the product of combustion by the supply of heat from outside, does not suffice to make that substance luminous. We are therefore, thrown back upon the conclusion that the generation of light in a flame is not a consequence, though it is an accompaniment, of the elevation of temperature.

The question now is: Can we go any farther? To do this we are led to consider individual molecular transactions instead of statistical averages; and the view presents itself that the combining atoms may, in losing their chemical energy, form directly systems of independent vibration where the radiation is such as to fall within the limits of visibility. If we picture such vibrating systems momentarily formed it is easy to see that by their collision one with another they may acquire, in a secondary way, increased translational motion, and so lead to a state of things where the greater part of their energy is degraded in the form of heat. The high temperature of a flame would then be a consequence rather than a cause of its light. This subject of the mechanism of luminosity, however, like so many others, has now become involved with the theory of electrons, and a chemist may be excused if he hesitates to pursue the subject farther.

The Use of Gas From a Hygienic Standpoint

By Vivian B. Lewes, F.I.C., F.C.S.

Theory and Practice in Favor of Gas.

With the advent of the electric light as an illuminant great stress was laid upon its enormous advantages from the hygienic point of view, and its supporters still make the claim that it must, of necessity, be far more healthful to use as an illuminant than coal gas. It has, not unnaturally, been assumed that owing to incandescent electric lighting adding nothing to the impurities in the atmosphere, and what is quite as important, withdrawing no oxygen from it, it must be the most hygienic form of illumination to employ. But in the years which have elapsed since electricity was pressed into the service of man for illuminating purposes it has become perfectly clear that, although electricity is inactive as regards vitiation of the atmosphere, a gas lighted room will nearly always be more pleasant and healthy to live in than one lighted by the newer form of illuminant.

I have in my mind at the moment a hall which in the old days was lighted by gas, and in which a large audience could with comfort sit through an hour's lecture or with pleasure through a three hours' dinner, but which with the march of civilization had its illumination changed from gas to electricity, the latter being employed with all the latest refinements to effect the lighting under the best conditions; with the result that any large gathering within its walls leads to a state little short of asphyxiation. It is with the various factors that lead to this anomaly that I now desire to deal.

In the ordinary dwelling-house the attempts at ventilation are of the most primitive and inefficient character. Indeed, in the majority of households, the efforts of the inhabitants seem to be directed to getting the rooms as nearly air-tight as possible, in order to render them warm. But this soon serves to render the air so vitiated as to be unfit for breathing. In the course of ten hours a man breathes out 6 cubic feet of carbon dioxide, and as the air already in the room contains 4 parts of carbon dioxide in 10,000, in order to reach the sanitary limit he can only add 2 parts more of carbon dioxide to each 10,000 of air, so that in the ten hours he must be supplied with 30,000 cubic feet of fresh air. In other words, if the air of a room be not changed the room must be of a sufficient size to contain 3,000 cubic feet if it is to be inhabited by him for one hour, whilst in the case of a bedroom in which he is to spend seven hours, it would have to be of 21,000 cubic feet capacity. This is manifestly an impossibility. Therefore arrangements are made by which the air in a room can be constantly changed; and as this can be done three or four times in an hour without creating draughts, the air supply can be diminished to 750 to 1,000 cubic feet per inhabitant per hour in rooms which are to be occupied for any length of

time. This is the basis on which the ventilation of properly constructed buildings is arranged.

It is the organic matter given off from the lungs and tissues during respiration that it is essential to remove from the air, and before one can condemn the atmosphere in an enclosed space by mere analysis, the source from which the carbon dioxide was produced must be known, as without the presence of the organic matter it is possible to live in an atmosphere containing 20 parts of carbon dioxide in 10,000, without injury to health.

Diffusion as an Aid to Ventilation.

In all processes of ventilation the great factors which enable us to change the atmosphere in our dwelling-rooms are the air currents set up by alterations in temperature and inter-diffusion between volumes of air at different temperatures; and it is this which gives coal gas its great advantages as an illuminant over electric lighting. The combustion of 1 cubic foot of coal gas will use up 6 cubic feet of air, giving, approximately, half a cubic foot of carbon dioxide and nearly 1½ cubic feet of water vapor. Using an incandescent mantle on an atmospheric burner, about 4 cubic feet of gas per hour is consumed, and this gives 2 cubic feet of carbon dioxide, which would very soon suffice to raise the proportion of carbon dioxide above the sanitary limit of 6 parts in 10,000. But although everything be done to render the room as air-tight as possible, it will be found that the proportion of carbon dioxide is enormously less than it should be by theory, this being due to the fact that alterations in the temperature of the air of the room set up currents and actions which tend to bring about a change of the atmosphere.

Carbon dioxide is a gas considerably heavier than air, so much more so, indeed, that it can be poured from one vessel to another almost like a liquid; but like all other gases it is expanded by heat, and as the foul air coming from the lungs and containing some 5 per cent. of carbon dioxide is at practically the temperature of the body, *i. e.* 98° Fahr., it at once rises towards the ceiling, whilst the products of combustion from the gas burner, being at a still higher temperature, also rush up to this point, so that the foul air is always to be found at the top of the room. One might think that this foul air when cooled down would descend into the room again; but here the process of diffusion comes into play, a process by which gases, instead of arranging themselves, like other forms of matter according to their weight, undergo a mingling or diffusion, the rate of such mingling being dependent upon their weight, a light gas mixing rapidly with others whilst a heavy gas diffuses more slowly. It is found that, once mingled, the gases remain in perfect admixture, so that in the present case the heavy carbon dioxide will not again separate from the air into which it has become diffused.

This so-called diffusion of gases can be and is experimentally shown in many ways. It will take place with even greater rapidity through porous solids than when the gases are left simply in contact with each other; and as the plaster of the ceiling and the bricks or other building material of which our walls are composed are full of minute openings or pores, they allow gases

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Distribution of Carbon Dioxide in the Air of a Dwelling-Room with Gas and Electric Incandescent Lighting.

Capacity of Room.—2,700 cubic feet.

Gas Lighting.—Two Welsbach "C" burners (on pendant), consuming 4 cubic feet of gas each per hour, and giving 140 candles.

	Carbon Dioxide. Parts per 10,000.	Temperature. Degrees Fahr.
Outside air	0.03	61
Between joists ...	0.06	66
Ceiling level	0.44	74.7
Breathing level ..	0.05	63

Electric Lighting.—Three 16 candle-power lamps.

	Carbon Dioxide. Parts per 10,000.	Temperature. Degrees Fahr.
Outside air	0.03	61
Between joists ...	0.04	61.5
Ceiling level	0.09	62.5
Breathing level ..	0.06	61.7

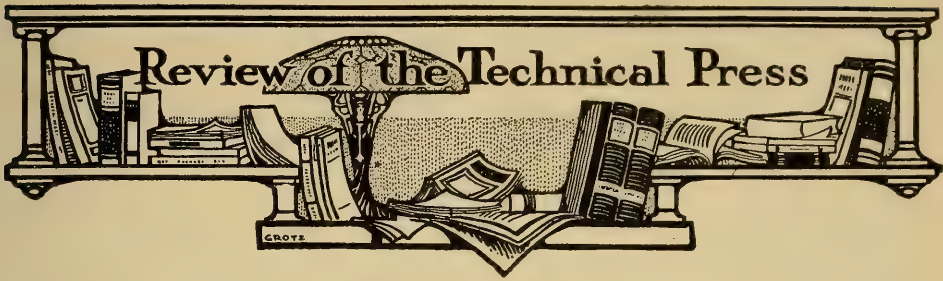
to diffuse through with considerable rapidity, the force of diffusion being aided by a second force called capillarity. The result is that even though the ventilation of a room has been neglected, and no proper outlet has been arranged at tne top for drawing off foul gases, diffusion through the ceiling and through the walls in the upper part of the room provides so rapid an egress for the hot gases that they have not time to mingle with the air in the lower portion of the room, whilst fresh air is being constantly drawn in through every crack and crevice left by the jerry builder.

Gas Lighted and Electrically Lighted Rooms.

An interesting series of experiments which I have made shows conclusively that, taking an ordinary dwelling-room lighted by gas and then the same room lighted by electricity, the air of the lower portion of the room, if one or two people only are present, is as pure with gas lighting as with electric lighting, whilst if a large number are present the advantages are enormously in favor of gas, the air with electric lighting becoming rapidly so organically impure as to be positively dangerous to health.

If a number of people be in a room, the organic exhalations as well as the carbon dioxide and water vapor evolved during respiration rise, and, reaching the level of the gas burners, are rapidly swept up to the ceiling by the rush of hot gas from the burners, the flame and heat destroying and charring a large proportion of the germs. The hot air reaches the ceiling and diffuses through the plaster and walls in the upper part of the room, and in doing so the charred organic matter is left behind, filtered off on the surface of the plaster, and rapidly causes that discoloration of the ceiling which you invariably find in a town atmosphere above the gas burner, and which is often wanting with country air. That this is the case is amply verified by the fact that if beams are present at the back of the plaster, diffusion is prevented at those points, and their position is plainly mapped out on the discolored surface.

When the room with its occupants was lighted by electricity there was no rapid uprush in this way of the products to the ceiling, and the organic impurities and carbon dioxide, leaving at body temperature, remained diffused throughout the whole of the atmosphere of the room, causing a far more rapid fouling of the air and injury to health. If such a room were entirely left for its ventilation to diffusion through the walls, it would soon acquire that sour smell which is noticeable in many rooms of the poor, in which, in order to keep in the warmth derived from their own bodies, all ventilation is cut off. This smell is due to the decomposition of organic matter filtered off during diffusion by the wall surface and undergoing putrefactive decay, giving the offensive odor; the only way to get rid of which is to strip the paper from the walls and lime-wash them as well as the ceiling. Then and then only does the smell disappear. When, however, this same diffusion through the ceiling and upper part of the walls of the room takes place in a gas lighted room, this unpleasant human smell, so characteristic of the "tube" railways, never appears, as the small quantity of sulphur compounds present in the gas (as was shown by the re-ed by electricity.



American Items

SPECIAL ILLUMINATING ENGINEERING NUMBER OF THE ELECTRICAL REVIEW.

As previously announced, the issue of September 14th, is devoted entirely to articles bearing on illumination, as follows:—

The Status of Illuminating Engineering, by Dr. Louis Bell.

Incandescent Lamp Development During the Last Twenty Years; by S. E. Doane.

The Recent Incandescent Lamp Developments and Their Significance; by Francis W. Willcox.

Economical House Lighting; by Van Rensselaer Lansingh.

The Flaming Arc Lamp; by J. H. Hallberg.

The Effect of Higher-Efficiency Lamps on Station Output and Income: A symposium from central station men in the United States and Great Britain.

The Helion Light; by Walter G. Clark.

The Sirius Colloid Lamp; by Paul McJunkin.

The Flaming Arc Lamp; by Thomas Spencer.

Photometry at the Bureau of Standards; by Dr. E. P. Hyde.

Some Artistic Requirements of Artificial Illumination; by Bassett Jones, Jr.

Photometric Units; by Preston S. Millar.

The Nernst Glower and the Present Status of the Nernst Lamp; by Otto Foell.

The Mercury Vapor Lamp; by Percy H. Thomas.

Recent Developments in Metallic Flame Arc Lamps; by G. Brewer Griffin.

The Moore Light and Illuminating Engineer; by D. McFarlan Moore.

With the exception of Mr. Lansingh's article, which describes the lighting of a colonial cottage, and Dr. Hyde's description of the photometric department of the National Bureau of Standards, there is practically no new matter in the various articles. As will be seen, however, by noting the several writers, each article is an authorative, but brief review of the particular subject treated.

Electric Lighting, by Geo. R. Metcalfe; *Western Electrician.* This is No. XXX of the series of articles by this writer which are "intended to survey briefly the whole field of applied electricity for light, power and heat." Considering the ground which the writer proposes to cover, the statement that the survey will be "brief" is rather superfluous. The present article deals with special lamps, and includes the Cooper-Hewitt Lamp, the Nernst Lamp, the Moore Vacuum Tube Light, Metallic Filament Lamps, Metallic Electrode

and Other New Arc Lamps. Metallic filament lamps are disposed of in a single paragraph, as are also the metallic electrode and other new arc lamps. Residence lighting is exhausted in three paragraphs. The lighting of auditoriums and offices, etc., in three paragraphs. While brevity is a desirable quality in technical literature, there is a point beyond which condensation leaves the matter so dry as to be worthless; and it would seem that the writer is peerlessly near this condition.

Progress in Arc Lamps; *Southwestern Electrician.* Reviews briefly the development of the arc lamp, and especially mentions the use of the enclosed arc lamp with diffusing reflectors, citing its use in various cotton mills in the South, pointing out its special merits for this purpose. Also briefly describes the metallic arc lamp, advocating its use for street lighting.

EDITORIALS.

Central Station:—

Cost of Light-sources: Quotes the comparison of costs given by Mr. Edgecombe, but gives no figures of its own deduction.

The Expert on Illumination: sets forth the claims of illuminating engineers, and points out their special field of work.

Re-filled Incandescent Lamps: A discussion of the relative merits of new and re-filled lamps, in which the latter is shown that it is not as black as it has been painted.

Electrical World:—

Illumination Photometers: A discussion of Mr. Miller's paper before the Illuminating Engineering Society Convention. The conclusion is that "it is the man behind the photometer that counts. Good judgment and a knowledge of the errors will lead to good results, even with indifferent apparatus; while it seems very doubtful whether any kind of photometer can be made fool-proof."

Flux of Light: A discussion of Dr. Sharp's Presidential address before the Illuminating Engineering Society Convention. The gist of the paper, and likewise the discussion is the suggestion that light be considered as a flow of energy, rather than rays having a certain intensity in a particular direction.

Diffuse Lighting: Discusses Mr. Millar's paper on the subject, read before the Illuminating Engineering Society Convention.

Comparison of Illuminants: Deals particularly with the methods of rating light-sources. It concludes that

"The true initial rating of any illuminant should be according to its mean spherical candle-power. This rating will give each illuminant full credit for all the light that it emits without regard to the direction in which the principal flux or flow of light is sent out. The comparison on the basis of mean spherical candle-power per watt is entirely fair, as far as it goes; but one must go farther than this initial comparison in figuring on the use of lamps for certain specific installations, and consider the comparative amount of light emitted in useful directions by the different sources of light when equipped with the reflectors and glassware best adapted to the specific case in hand."

Factory Lighting: Discusses the proposition made in a paper read by Mr. A. P. Biggs, before the Michigan Electrical Association, to use "gas arcs" for general illumination, with incandescent electric lamps for individual lighting of machines. The commercial view of the proposition is specially discussed.

Foreign Items

The Lighting of the New Zealand International Exhibition

By Albert Ford.

From The Gas World, London.

A more appropriate heading for this article would, perhaps, be "The Incandescent Gas Lighting Exhibition of New Zealand," for the one great feature of the exhibition, that shone out beyond all others, was the magnificent display of incandescent gas lighting. The whole scheme of artificial lighting was so thorough, and the illuminating effect so excellent, that it commanded both the interest and admiration of practically the whole of the visitors to the exhibition. The writer is of the opinion that the capabilities of coal gas as an illuminant have never been shown to greater advantage in any part of the world, and certainly never before equaled in the southern hemisphere. It was the one theme of comment and compliment from the opening to the closing of the exhibition. All this must be considered a most satisfactory result, indeed, for the original intention of the exhibition authorities, supported by the Government, was to light the whole of the exhibition with electricity and keep gas out altogether. Tenders were twice invited for complete electric installations, but they could not well be accepted, as Mr. Bishop, the secretary of the Christchurch Gas Company, could not be convinced that this one-sidedness of purpose was quite in keeping with his views of the fitness of things, so he reversed the order of the recognized procedure, and took the "horns by the bull." In other words, he submitted a tender for lighting the whole exhibition by electricity or gas, or by a combination of both, and at such a price that the original tenderers had no chance of success left. The ultimate result was that the Gas Company secured a contract for lighting with gas four important sections of the exhibition, the main corridor and part of the western corridor. The remainder went to the electricians, but, as it proved, tentatively only, for after wiring the other sections of the building, and lighting them by electricity, the result was so unsatisfactory, as compared with the gas-lit sections, that the exhibition authorities called upon the Gas Company to submit a scheme for the supplementary lighting of the electrically lit courts. This was duly forthcoming; and, with the exception of a few "frills" and a cluster here and there, the whole of the internal lighting fell into the hands of the Gas Company, and was done with incandescent gas.

This is how it was done. Although it was not immediately necessary for their ordinary requirements, the Christchurch Gas Company, to make assurance doubly sure, laid five miles of 10-inch high-pressure main, making a complete circle round the center of the city, put down a boosting plant, and to this high-pressure main connected the mains of the exhibition—some 1,741 yards of 10-inch to 3-inch, and 46,614 yards of 2-inch to ¼-inch wrought-iron tubing. They were thus able to maintain a pressure of five inches of water throughout; consequently, the mantles were kept full, and were brilliantly incandescent to the very top; and although the contract stipulated for a total candle-power of 356,630, the result of working at such a high pressure, together with the careful regulation of the burners, and the high state of efficiency at which the mantles were maintained, was an actual candle-power considerably higher than that stipulated in the contract. But the general amazement and satisfaction expressed on all sides more than repaid the Company for the little extra gas consumed.

Four hundred and thirty-two 500 candle-power Humphrey lamps; 84, 1,000 candle-power cluster pendants; 33, 210 candle-power fittings; 93, 140 candle-power fittings; and 524, 70 candle-power fittings were distributed throughout the exhibition building, making a grand total of 3,377. The gas consumed was 14,092,531 cubic feet, the mantles used in upkeep 6,438, and the chimneys 1,997. The exhibition was visited by no fewer than 1,966,811 people, and on the closing day 46,852 persons went through the turnstiles.

In addition to the gas contract, the Gas Company contracted to supply the electric lights for the footlights and for the floats on the stage of the Concert Hall, for which purpose there was installed a 30 horse-power Crossley gas engine and a 19 kilowatt generator, supplying 310 16-candle-power incandescent lamps. This electrical installation attracted a good deal of attention, if for no other reason than the subtle object-lesson it furnished, by showing the

enormous energy required to produce but a feeble glimmer, when its product was placed beside an incandescent burner. The Concert Hall itself was illuminated and ventilated by a central sunlight, controlled from the stage; this sunlight could be extinguished, or relighted, by an ingenious electrical apparatus.

The Machinery Hall was lighted with 84 10-light, or 1,000 candle-power pendants, on the by-pass or double pipe system. The main gas supply to the burners was brought down the central stem and distributed through the arms to the burners in the usual way. A second pipe running parallel to the main stem and forming a periphery to the pendant arms supplied the gas to the pilot lights. By this system the whole of these lights could be switched on or off at the same time—a much-appreciated feature of this class of lighting.

A competent staff of lamp lighters and cleaners were kept constantly in the building, and every night after closing time the burners throughout the vast structure were cleaned and adjusted where necessary, and the mantles renewed. The whole 3,377 burners were lighted every night, and it says much for the lighting and cleaning staff that the average mantles used were less than two per burner, and the chimneys less than one, for the whole period. There was not a single hitch, or a light out, during the whole period of the exhibition; and although the Company had some 250 private consumers inside the building and grounds they did not receive one single complaint.

Public Lighting of the City of London

From Journal of Gas Lighting, London.

The reports on the works executed by the Public Health Department of the Corporation of London during the year ending December 31 last, prepared by the Engineer (Mr. Frank Sumner, M. Inst. C. E.), which has just been issued, contains particulars in regard to the public lighting. They open with the interesting statement that during the year "the system of lighting by means of incandescent gas-burners was completed, and the last public flat-flame lamp removed from the city streets." The number of gas-lamps (including experimental lamps) paid for by the Corporation at the end of the year was 2,804—being a decrease of 35 during the twelve months, accounted for by the removal of a number of lamps in the side-streets adjacent to the thoroughfares lighted by high-pressure lamps, and also by lamps removed from certain courts. There were 2,710 square and 90 circular lanterns and 2,176 brackets in use; the hourly gas consumption of the ordinary burners ranging from 4.25 to 21.25 cubic feet, and of the high-pressure burners from 10 to 151 cubic feet. There were 66 back lamps and 26 special lamps in service last year. An additional 2,000-candle-power high-pressure lamp was put up in Lombard street, at its junction with King William street, in place of an electric arc lamp. The light from the new high-pressure gas-lamp at St. Martin's-le-Grand was found sufficient to permit of the electric arc lamp by the corner of this thoroughfare and Cheapside being removed; thereby effecting a saving of £26 per annum. The experimental lighting of certain main thoroughfares was continued during the year. The numbers of these experimental lamps are 35 low-pressure, consuming 7 cubic feet, 38 high-pressure burning 10 cubic feet, 46 burning 20 cubic feet, from one burning 30 cubic feet. The low-pressure lamps are in Fleet street, and the 20-feet high-pressure lamps are in Queen street and Queen Victoria street.

During the year five lamps of the new Scott-Snell type were fixed—one on the rest in Cheapside, and tour in Cannon street, Dowgate Hill, and Budge Row. In regard to them, Mr. Sumner says: "These lamps are of a self-intensifying character; and a lighting value of 600 candles is claimed for them, with a consumption of 15 cubic feet per hour, at an annual cost of £9 5s. per lamp per annum. The reliability of the automatic mechanism has not been sufficiently proved to warrant an extension of the use of this type of lamp at present."

The number of defective gas-lights observed and reported upon by the Inspector of Gas Lighting during the year was 1,813; being 1,654 ordinary and 159 high-pressure. The number observed by the police was 34 incandescent and 3 high-pressure lamps. The details of lighting defects in the ordinary incandescent lamps were: Feeble lights, 1,298; lights went out, 52; not alight during night, 33—total, 1,383. In addition, 271 defects in the lanterns and burners were reported to the Gas Company, and they were rectified. The readings of the meters attached to the public lamps in various parts of the city show that the full

contract quantity of gas is given at these lamps; and Mr. Sumner is of opinion that the stipulated amount is furnished generally throughout the city, and that the regulators of the lamps are kept in proper condition. The public lamps were lighted whenever fog or unusual darkness occurred. This happened on eleven days during the past year, and entailed a cost of £180 1s. 6d.

On the subject of electric lighting, Mr. Sumner says the lighting of most of the main thoroughfares of the city by arc lamps was continued throughout the year. The number of lamps in operation at the close of the twelve months was 449; being a reduction of 16. The cost of each is £26 per annum. These lamps were lighted on five days when fog or unusual darkness occurred. The number of defective electric lamps observed during the year was 178; and the City of London Electric Light Company were fined for each failure. The Company withdrew their refusal to take down their arc lamps in Queen Victoria street and Fleet street, which had been lighted by incandescent gas-lamps, and the extinguishing of the arc lamps in their eastern district, which had been lighted by high-pressure gas, and proceeded with the extinguishing of the lights and the removal of the columns and brackets. In addition, five arc lamps were removed during the year in connection with a rearrangement of lighting. It was also decided to remove the arc lamp in Fore street, near the entrance to Cripplegate Churchyard, and substitute gas-lamps for it.

The Luminous Arc

By André Blondel.

From Bulletin de la Société Internationale des Electriciens.

The *luminous arc* is distinguished from the purely industrial point of view, from the ordinary carbon arc, by the fact that first is a great deal longer and more luminous than the latter. The luminous arc is the actual source of light. In the carbon arc the bright spot on the anode forms the principal source of light. The luminous arc has no pronounced crater.

From the theoretical point of view the various luminous arcs have the common property of being composed of vapors possessing grat electric conductivity, which is obviously due to the presence of free ions in large quantities. Besides this the drop of voltage in the vicinity of the anode is more feeble than in the carbon arc. Finally—the arc vapors themselves are subject to the oxidizing influences of the surrounding air just as the electrodes from which they emanate. The *means by which the luminosity of arcs may be increased.* In all electric arcs in general the luminosity is produced as a result either of luminescence or incandescence, two phenomena belonging to different categories. The task of the illuminating engineer consists in either increasing the incandescence, the luminescence respectively, or combining both in order to attain the highest effect possible.

I.—*Incandescence.*—The principal defect of all sources of incandescent light is their low efficiency, resulting from the enormous disproportion existing between the visible radiation, *i. e.,* whose wave-lengths are comprised between the limits 0.4 and 0.8, and the invisible radiation. This disproportion attains its maximum in the case of black bodies, which give the highest efficiency of radiation per unit of surface, but unfortunately altogether in the shape of calorific rays. The only visible part of the latter is to be found to the left of the vertical corresponding to 0.8μ This useful radiation is so small that it cannot even be presented with precision. It cannot surpass 0.1 per cent., of the total energy at red heat and 0.01 per cent., at the highest temperature attainable (according to the comparative investigations of Professor Wedding in the *Journal für Gasbeleuchtung,* 1905) the relation between the visible and invisible radiation and the total energy varies 0.02 per cent., for petroleum lamps, 0.19 per cent. for the carbon filament and 0.32 per cent. for the ordinary arc).

Two methods of increasing the efficiency present themselves: Either to subject the radiating body to a higher temperature or compel it to emit a more favorable form of radiation.

All increase of temperature increases the total intensity of radiation. According to the law of Stephen Boltzman, the total energy of elementary radiations E of the spectrum increases as the fourth degree of the absolute temperature T.

$$\int_0^\infty E\lambda\delta\lambda = A\,(T^4 - T_0^4)$$

(A is a constant), T_0 is the absolute temperature of the surrounding space. However, at the same time there is a tendency on the part of the increasing temperature to replace the maximum from the visible part of radiation, *i. e.*, in the direction to the left of the spectrum. This tendency is expressed in Wien's law of replacement, in virtue of which the length of the wave $\lambda\mu$ of maximum radiation is inversely proportional to the absolute temperature

$$\lambda\mu = \frac{B}{T}$$

(B being a constant equal to 2940 for theoretical black bodies and 2630 for polished platinum, according to Lummer and Pringsheim).

The amplitude $E\mu$ of the maximum radiation varies, however, more rapidly than the total area of the curve and is proportional to the fifth degree of the absolute temperature,

$$E\mu = DT^{a}$$

(For black bodies with L — 5, D being a constant equal to 0.2188 x 10-17 for polished platinum L-6.)

In order to raise the maximum radiation to the most favorable length (0-55 according to Langley) it would be necessary to reach a temperature of 5,880 degrees at least equal to that of the sun (as L μ descends to 1.47 for 2,000 degrees and 2.94 μ for 1,000 degrees). For the ordinary arc the absolute temperature T is in the neighborhood of 3,750 degrees and $L\mu$ of .07 μ Finally the distribution of energy of the spectrum of black bodies is according to the more complete law of Plank (which law includes the previous one).

$$E\lambda = \frac{S\,\lambda - 5}{e^{\frac{a}{e}}T - 1}$$

(e being the base of the heperion logarithm and A a constant equal to 5 B, approximately 14600, S another constant.) According to this law there is no hope for the improvement of the efficiency of a black body, such as carbon is, in a higher degree than any other element known, the realizable elevation of temperature in practice being rather limited. The maximum terrestrial temperature at our disposal, the temperature of the pure carbon arc, reaches only about 3,500 degrees at the crater (according to Violle), a degree of heat limited by the vaporization of carbon in the highly incandescent crater. (The property of the new metallic filaments to withstand higher temperatures than carbon filaments, in spite of the fact that carbon is the most infusible of all known bodies, seems to be due to their higher vaporization point under the combined stress of heat and electric tension. These precious properties seem to be attributable to the high atomic weight of these metals (191 for osmium, 183 for tantalum, 84 for tungsten, instead of only 12 for carbons).

The electro-vaporization point of a body is different from the ordinary boiling point and depends, in a great measure, of ionization processes, as the vapor is electrically charged, especially in case the incandescent surface possesses a negative polarity. Mr. Wehnelt even proved that the oxides of earthly alkaline metals may produce cathodic rays at a very low tension (some hundred parts of a volt), when placed in vaccuo on a platinum cathode raised to incandescence.

This explains the progressive increase of the brilliancy of the crater of the carbon arc with the corresponding raise of current. In order to obtain a higher luminous efficiency of a source of electric light it is possible to look for electrodes made of *white bodies* or bodies behaving similar to white ones and presenting a more favorable law of radiation than that formulated by Plank for *black* bodies. Such non-carbon electrodes may either emit less heat rays or display an exceptional power for emitting visible radiation.

The first case is presented in such bodies as the oxide of thorium, having a rather weak emissive power. It is known that its effect in the Bunsen burner is lower than that of oxide of iron. In the second case, we have to do with bodies possessing high emissive power localized in the useful part of the spectrum. This represents not a temperature displacement, but an inherent property of the body. This seems to be the case with oxide of cerium. This is the reason why small quantities of the latter combined with the oxide of thorium result in the Auer (Welsbach) mantle in such a surprising increase of luminous efficiency. However, the greenish-yellow radiation develops very feeble heat radiation. This theory of Le Chatelier was supplemented by the labors of Fery and fully verified by Paschen.

If we want to profit by this highly advantageous property of selective radiation in order to increase the luminous efficiency

of the electric arc light, it is necessary to take into account the law of selection or replacement. As the temperature of the arc is considerably higher than that of the Bunsen burner, the maximum intensity will shift from the side of the more refringible radiation and the yellow radiation will pass into violet and ultraviolet. The author tried in 1900 to employ for the mineralization of carbon electrodes rare metals, especially Auer's mixtures. A very weakly luminous arc was obtained, a great deal less luminous than that produced by salts of calcium. For the latter, namely, the law of replacement or selection is favorable. In the temperature of the Bunsen burner their color is yet reddish, while in the arc the maximum radiation is replaced toward yellow, *i. e.,* towards the region most favorable in the spectrum from the physiological viewpoint. The choice of utilizable substances for increase of light at the high temperature of the arc is, therefore, more limited than it is generally thought *a priori* and is entirely different from the choice we would make when low temperatures would be concerned. According to the experience of the author and others working in the same field, the white chemical combinations of calcium and the bodies nearest related to it, as for instance, barium, stronthium, zinc, give the best results as mineralizers of carbon arc electrodes. Berillium was mentioned in this respect. However, it is too rare a metal to be of industrial importance. The colored oxides or salts of iron or similar metals give only very weak luminosity, which is not surprising at all, because they approach in their properties the black bodies and their electrovaporization takes place at a considerably lower temperature than carbon.

II.—*Luminescence.*—The electric arc also represents the phenomena of an entirely different order, and which can be called the phenomena of luminiscence, having their place exclusively in the gaseous part of the arc.

According to Zeeman's theories the luminous effect of mineralized flames (luminous arcs) is due to the oscillation of free ions whose mass is very small in comparison with the non-ionized molecules. The latter made incandescent by the impact of the ions, vibrate forcibly at a considerably lower frequency corresponding to the colorific rays. But with their penetration into the column of gas it is thought that they may have a light emissivity of an almost monochromatic nature (or many monochromatic lights) without such a combination with colorific radiation as would be the case with the low frequencies peculiar to the incandescent solid bodies. This luminescence cannot be obtained by simple heating. The increase of temperature would only tend to increase the pressure of the gases. A chemical combination or a vibration produced by the passage of an electric current is necessary. Experiments of Moor proved that the Geissler's tubes may be also employed as a source of light, giving better efficiency the higher the frequency of the current employed. He obtained also a true source of cold light. But the difficulties of its practical application were so far considerable and the candle power per unit of space is rather too weak for practical utilization. The only instance where the luminescence of bodies may be utilized with practical advantages are the luminous flames.

For instance, the mercury arc—so efficient a source of light as it is—is just remarkable for its low temperature, reaching only a few hundredths of a degree.

In order to obtain the highest possible luminosity by means of luminescence (as opposed to incandescence) of the column of gas of the arc—it is necessary to find vaporizable substances, that would be at the same time easily ionizable and present the most advantageous spectrum; in other words, it is necessary to find bodies emitting spectral rays principally in the visible part of the spectrum or as little as possible beyond it. At the same time care must be taken to attain among the visible rays, those having the most favorable physiological effect, *i. e.,* the yellow and green rays, to be placed in the vicinity of 0.55μ, according to Langley's researches, and at any rate it must be tried to obtain a light as near in its properties to daylight as possible. This last condition is very poorly met by the mercury arc, as known, on account of the absence of red rays from the mercury vapors (at the ordinary tensions, at least). However, it is a generally recognized fact, that metallic vapors, just as carbon vapors, present a spectrum rich in blue, violet and ultroviolet rays. The research in the field of the most favorable metal is, therefore, necessarily of an overwhelmingly empirical nature. This research is directed into two different channels, the arc in vacuuo and the arc in free air.

The only metals utilizable in vacuuo are those having a low melting point, as for instance, mercury that may be raised to boiling and vaporization temperatures in an exhausted glass tube. Extending their inves-

tigations and replacing the glass tube by tubes made of fused quartz, Stark and Kuch obtained interesting results with another series of metals—lead, bismuth, tin, antimony, sodium, etc. (*Physikalische Zeitschrift,* Sept. 1st, 1904, and *Eclairage Electrique,* 1905). The results attained with these metals are rather remarkable from the theoretical viewpoint, but did not lead so far to any practical application, partly because the spectrum of these metals have no marked and actual superiority in respect to luminous efficiency and partly on account of the necessity of exterior preliminary heating of the tube and the metal contained in the latter, as without which preliminary heating to the fusing point of the metal no light can be produced. Besides this, the heat of the tube has to be so controlled as not to exceed a certain limit. All this is in the way of an industrial use of similar lamps.

The other metals having a very high melting point cannot be used except in free air. The metals of the calcium series when used especially as anodes furnish a sufficiently brilliant spectrum, which, however, is due to incandescence, namely, the ions of alkaline compound and earthly alkaline compound seem to move in the direction from the anode to the cathode. The author observed this phenomenon in 1901, and utilized the property in his arc lamps by mineralizing his positive electrodes. Riecke and Stark more recently demonstrated that the ions introduced into a current are transported in the identical direction by experimenting with a bead of a salt of an alkali or calcium.

Contrarily ordinary metals as iron, copper, etc., arc very feebly luminous.

Only titanium and similar metals, for instance, chromium, tungsten, etc., present a very favorable luminescence, however, only when emitting an arc as negative electrodes. So far the differences in the comparative degrees of luminescence among various bodies remained unexplained. The specific luminescence of various bodies is recognized as peculiar individual properties (*propriétées idiosyncrasique*), as most of the chemical properties of bodies. All that can be done is to recognize that these properties are common to many elements belonging to the same family.

The spectrum of luminescent arcs are formed of brilliant rays in conjunction with some bands. According to Stark the rays are created by oscillations peculiar to positive ions and are intensified with the corresponding increase of temperature; consequently, they are of special intensity in the vicinity of the cathode as the short rays observed by Kowalsky in high tension electric arcs (*Bulletin de la Société Française de Physique Seance* de May 5, 1905). By increasing the intensity of the current, it may be observed that the lines traverse the entire spectrum, but remain more largely on the side of the potential energy—radiation of the cathode. According to Stark the bands are the result of the potential energy—radiation of the electrodes at the time of their recombination with the positive ions. Their intensity does not increase with the temperature, but depends solely upon the number of recombinations per second, a number which cannot pass over a certain limit (*Phys. Zeits.,* Sept. 1st, 1904).

In the luminous arc formed between min- the essential role of the cathode for the lighting of the electric arc and the necessity of its preliminary vaporization (*Revue Générale de Sciences,* July, 1901, p. 666).

It is this property of the metallic arc that returned to us later, from America, under the queer (bizarre) term of the "repulsion of the cathode." This reminds us of the ancient explanation, according to which opium puts people to sleep because it possesses somniferous properties. The phenomenon is easier explained by stating *that there can be no arc without the electrovaporization of the cathode.* Stark established the general applicability of the law and the importance it has for the distinction between the arc phenomenon and the spark discharge phenomenon. Stark and Cassuto demonstrated that it is possible to entertain an arc between a hot cathode and cold anode (formed for instance by a cylinder rapidly rotating around its axle and near the generator to which the cathode is approached). While the passage of electricity in the inverse sense is impossible. The author prefers the term electrovaporization to the term *electrization* used by Stark, as the latter appears to him too vague.

Due to the superior mobility of the negative ions, which seem here to be composed of free negative electrodes and whose mass does not exceed 1/1000 of an atom, these corpuscles projected from the cathodic terminal attain a considerably higher velocity than the heavier corpuscles emanating from the anode. This effect is not noticeable in ordinary industrial arcs. But it appears with great neatness in arcs of high intensity

between pure carbons and especially between mineralized carbons. For instance, in an arc of 80 amperes and above the flame of the mineralized anode is projected in the direction opposite to the anode by the cathodic jet from the cathode of pure carbon touching it directly. This jet is so strong that it produces a crater on the extremity of the anode distorted obliquely when the cathode is slightly out of plumb and pushes the flame in the opposite sense, even when the carbons are placed vertically, one above the other, with the anode below. With the industrial arcs of lower power, for instance of 12 amperes, the aspect is different and two brilliant points appear, one more luminous at the anode, the other smaller at the cathode. (See photos published in the *Eclairage Electrique,* March 16, 1907, pp. 379-380.) Placing the anode under the cathode the brilliant point emanating from the anode licks the cathode and spreads out around the base. But there is generally on this point or even on the lateral side of the cathodic cone a small more brilliant spot from which vibrates into the flame a small luminous spot which indicates the presence of a cathodic jet. When the two carbons are moved away from each other by increasing the available voltage, and especially when care was taken to mineralize them both with alkaline salts, they display (especially when they are in a horizontal position) two bright spots well to be distinguished, very long and projecting sometimes on on side, sometimes on the other side in a capacious manner. The two bright spots seem to be independent of each other. However, as soon as they stop to touch each other, the arc is getting extinguished. Lenard, who particularly studied with a spectroscope the distribution of luminous intensity in the long cathodic and anodic flames produced by carbons rich in alkaline salts (*Drude's An.,* July, 1901), stated that they are each of them formed by many flames corresponding to the different series of spectral rays and that the radiation at different points appeared to be determined more by the shape of the flames than by the distribution of the electric current on them. The flames of the principal series have to touch each other under penalty of extinction of the arc, while the flames of the other series may be separated by dark spaces of more or less greater size. All these flames appeared to be involved and seem to be formed of concentric layers representing various radiating properties and separated by non-luminous layers.

These simple observations, especially evident in mineralized arcs, are sufficient to show that in general the phenomena of the electric arc are the result of the production by both electrodes of vapors charged with free electric bodies that have to recombine at a certain point of the process. This vaporization is not a simple phenomenon of change of physical state, because it is accompanied by a real ionization of one part of the atoms at least composing the produced vapor. That is why it is called electrovaporization.

There are many hypotheses for explaining the way the heat necessary for the decomposition resulting in electrovaporization, once the permanent *regimé* is established. Stark admits that the heat is generated by the impact of the positive ions on the cathode.

He also believes that the anode is heated by the impact of negative ions. But in the long flaming arcs produced between mineralized carbon arcs, it rather seems to go on a recombination of both kinds of ions at the meeting point of the two anodic and cathodic jets. The electrovaporization is probably kept up by the liberation of heat due to the resistance to passage on the surface of the electrodes.

The anode has the tendency to attain incandescence in consequence of the impact of the ions. But there may be cases where it would be desirable to check the process of the resulting electrovaporization. This can be obtained by making the anode of a material not easily vaporizable and kept cold either by external artificial means or by its size. For instance, in the mercury arc the increase of the arc temperature and increase in luminosity resulting from excessive vaporization is not proportional to the energy expended. It is, therefore, advantageous to keep the anode cold.

(*To be continued.*)

Miscellaneous News

CLAY CENTER, KAN. — The Clay Center municipal electric lighting plant, over which there has been so much discussion, has been started and is now serving electric lights to patrons. The city commission which is to have complete charge of the Clay Center water-works plant and the municipal electric light plant has also taken charge. It is expected that this commission will conduct these municipal enterprises and through this commission the plants are expected to be a success.

COLUMBUS, OHIO.—A novel experiment in furnishing commercial electric light and power in an American city is promised by the People's Municipal Light & Power Co., recently incorporated here with $100,000 capital.

A large power plant is to be erected near the city water supply storage dam in the Scioto River, to use the water going over the dam. An auxiliary plant, for steam or other power, will be installed for use during three months in the year when water is low and to supplement the water power at other times.

A proposal is to be made to the city for the use of the water and to string wires on poles of the municipal street lighting plant. The contract will provide that current is to be furnished at a maximum rate of 5 cents per kilowatt, with reductions according to a scale agreed upon, as the cost of production decreases. It is estimated that while current costs exchange companies over 5 cents, it may ultimately be delivered to consumers for 3 cents.

The city contract will provide that every share of stock must represent actual cash invested. All stock will be in the hands of a trustee for the city, and when net earnings exceed a stipulated amount, the surplus is to be returned to consumers in reduced charges. No combination in restraint of competition or agreement with the existing monopoly can be made. The city may purchase the plant for cost, with 6 per cent. interest added at any time. Books are to be regularly inspected by the municipality.

PASADENA, CAL.—Manager Charles C. Glass reported to the city council that during the month of August the municipal light plant saved the city $974.97.

Under the contract with the Edison Electric Company the same light would have cost the city $2,080, whereas under the present regime it cost, including both operating and fixed charges, $1,105.03.

Manager Glass estimates the operating expenses of the plant during August to have been $974.61 and the cost per single arc lamp $2.80. The department now has in operation 302 arc lamps and 103 32-candle-power incandescent lamps.

There has not been a single shutdown during the month from any cause, although the commercial circuit has been kept running a total of 357 hours and twenty-five minutes and the arc lamp circuit, on a moonlight schedule, 243 hours and thirty-five monutes.

The present condition of the municipal electric lighting plant has been shown by Ezra F. Scattergood, the electrical engineering expert, to be far from the perfect piece of construction work that has been maintained for it by Superintendent Charles C. Glass, and whether the latter approves of the proposition or not the probabilities are that a third expert engineer will be called in to settle matters of doubt that now haunt Mayor Earley and members of the City Council. If a third expert is not called in the city administration will have to choose between the representations and recommendations of Superintendent Glass or Mr. Scattergood and at the present writing the latter stands in the better light with the administration officials.

A PLEASING SHAPE AND CUT DESIGN FOR BRACKETS

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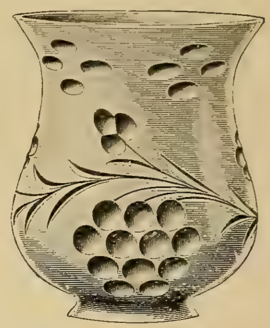

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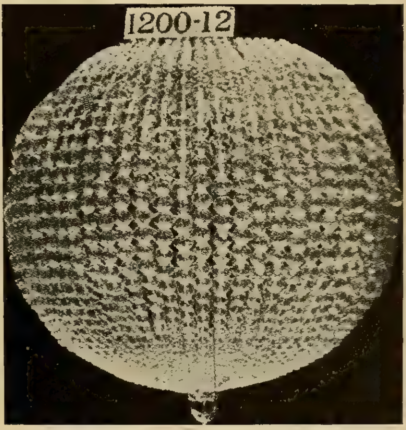

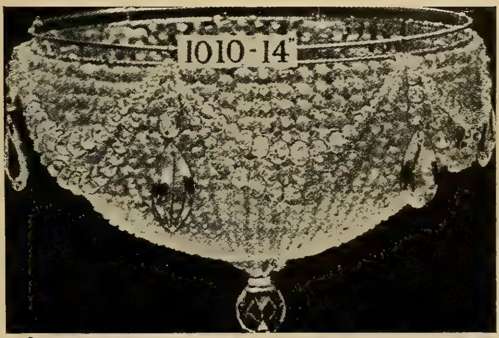

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THE ILLUMINATING ENGINEER

Vol. II. OCTOBER, 1907 No. 8.

Spectacular Lighting in Cincinnati

By W. L. Byron.

It is nine months since the Union Gas and Electric Company, Cincinnati, Ohio, inaugurated a campaign for more commercial lighting, the vigor of which attracted the eyes of electric men the country over.

It was a part of the aggressive policy infused into the conduct of the company by its president, Norman G. Kenan and his Eastern associates, the representative of the latter being Geo. Williams, of New York. Part of this plan was the addition to and amplification of its new business department. The success of the campaign has abundant proof in the vast increase of electric illumination in mercantile and other districts, some of the most noteworthy of which are here shown.

The photo shown on the cover page of this issue is that of the Mabley & Carew Co., department store. There are nearly 6,000 4-c.p. lamps used in the outlining of this building, operated on the electric company's flat-rate patrol system, burning from dusk until midnight. The wiring is all done in iron pipe conduit, which makes the installation very attractive by daylight, while the night effect is most wonderful.

The Mabley, Carew Co. consider this one of their most effective forms of advertising. One effect has been to make this the most talked of firm in Cincinnati, besides attracting considerable attention throughout the States as it is probably the largest installation of its kind in the country.

Another recent and interesting installation is that of the Potter Shoe Co. This photograph shows what good effects may be had by an artistic arrangement of electric lights. In this case an otherwise unsightly iron awning is transformed into a brilliant canopy, using a little over 300 4-c.p. lamps. Like all other signs in Cincinnati this burns until midnight.

The group picture shows Cincinnati's most brilliantly lighted block. It is also said to contain as many or more incandescent lamps than any one business square in the United States.

A singular feature in connection with this block is its reversal of an

A STRIKING EXAMPLE OF GOOD SHOW WINDOW ILLUMINATION ENHANCED BY AN ATTRACTIVE ELECTRIC SIGN.

CINCINNATI'S MOST BRILLIANTLY LIGHTED BLOCK.

old accepted theory of commercial lighting men that there is a "saturation" point in the addition of new business which renders it more difficult to close business in such locations. In the instance at hand the Union Gas and Electric Co. secure more business from this apparently saturated center than from any other section of the city, and in addition it comes with less effort.

The photograph of entrance to Luna Park, shows conclusively the good ef-

fects to be had with a very few electric lights when intelligently placed.

The photo of "Peoples' Hippodrome" shows a good arrangement of sign and outline lighting and one that is very effective. There are 650 4-c.p. lamps shown here, with a recent addition of 145, making a total installation of 795 4-c.p. lamps burning until 12 o'clock.

The next photograph shows the office building of the company artistically outlined, using almost 2,000 4-c.p. lamps. Most certainly the little 4-c.p. lamp has wrought a wonderful change in this instance.

The sign and arch over the street are part of the display of a large clothing store.

Reminiscences of the Pioneer Days of Electric Lighting

By George Wilfred Pearce.

Not the least among the debts which the art of design owes to the science of electrical engineering is the foundation of the art of designing and making electric and gas lighting fixtures in strict conformity with the canons of true art. At the time when electric lighting was in its infancy there were not to be found in Great Britain or North America more than ten designers of gas fixtures who had received an art education. Art had almost ceased to have any standing in that industry after the great jewerly firms, Messrs. Tiffany & Co., and Ball, Black & Co., and a few other firms of high standing, had ceased to make and sell gas fixtures. A few high-class firms, like Messrs. Shreve, Crump & Low, Boston, kept on making artistic gas fixtures, and as soon as a demand was created for electric and combination fixtures, they responded to the requirements of the electrical engineering interests, and have continued to hold a high place in the art to this day. But makers who put fixture making under the guidance of art were then, as now, very few in number.

It was the writer's place as the chief of the engineering department of one of the pioneer corporations which for a long time was the most important factor in the electric light and power apparatus making field, to provide the agents in all parts of North America, and in several foreign countries, with designs for brackets, newels, chandeliers, etc. I had been educated in Europe in decorative art in order to take up that department in a business which has been carried on by my family in this country for upward of a century. But I had acquired a distaste for every form of art, and my sojourn abroad with its atmosphere of art, and most of the sculptors, painters, and patrons of art, and the numerous hangers-on at studios, bored me; and whenever my duties took me to art galleries to copy or to study the old masters, I used to bemoan my hard fate in being kept from home and the participation in the work of engineering, which I loved above all things.

At last I finished my art studies, and came home firmly resolved to pitch art to the bow wows, and to take up the study of mechanical engineering, which I did. Consequently, when the early days of electrical engineering came, and I got into that line of work, it was quite natural that the president of that important company, who had been a neighbor of my father, recalled that I had studied art; and so he put me into the fixture department, with the order to make it as strong and as influential in building up an atmosphere of high art as the liberality of the management would permit. This gentleman was not only a great financier and a high class citizen, but he was also a lover of the fine arts, and had a sound education in several arts. The first sum of money alloted to my department was $100,000. A small part was expended in fitting up draughting and modeling rooms. In order that there might be "safety in a multitude of counsellors," I asked a number of distinguished architects and decorators to pass judgment upon the best method of conducting the department. In the meantime, a large library had been gathered that in-

cluded many more works on design than had ever before been placed under one roof in the metal-working trades.

This library was arranged, and the card index thereof made by two specialists in library work. When the library was ready, cards of invitation were sent out to all the architects and decorators in North America, and they were informed that the library was at their service at any time. A large stock of models of fine art work in metals was then purchased at home and abroad, and by that time orders for fixtures began to come in, slowly at first.

Within a year the business had grown to large proportions and for several years taxed the capacity of plants to meet requirements. The hardest work in starting the plant was to find educated designers. The results from advertising were unsatisfactory. The designers of gas fixtures who applied were all ignorant, rule-of-thumb men, who had grown up from service as errand boys in factories carried on by very ignorant men, whose products were copies of English and German fixtures that had been in the market for sixty to eighty years. Urgent necessity compelled us to put on a few of these gas fixture designers in order to get out working drawings for low-priced fixtures. They had no knowledge of electricity, and could not be induced to study any phase of the new art. One of the best designers in that field was in our service five years, and at the last he did not know whether a volt was a bird or a scientific term; and he never was able to get through his head the one salient fact, that because a gas fixture was made in such and such ways to serve the ends of gas engineering, there was no reason why the same limitations should obtain in an electric fixture. To the last, all his designs were nothing but clumsy gas fixtures fitted with appliances for the incandescent lamp.

The first designer who was able to grasp the principles of the science of electric lighting and utilize his knowledge in striking out into high art paths in making electric fixtures was Mr. C. McKay Smith, now chief illustrator for *The Scientific American*, and longtime the official draughtsman to the Navy Department in making superb water colors of men-of-war. He is also by far the best illustrator of yachts and yachting, and is the first artist whose early training was wholly in the electrical engineering field. Mr. Smith was with me several years, and he certainly led the art of fixture designing to the highest plane, and eliminated all those hide-bound and antique methods of design which for years had made the typical American gas fixture the most abhorrent form of vulgarity in metal work.

For two years the artist in association with this great field of applied art in electrical engineering, and who did the greatest amount of art work, was the late Charles B. Atwood, afterward architect of the Fine Arts Building at the Chicago Exposition, and thereafter associated with Mr. Burnham, the Chicago architect who has placed the whole world of art in his debt.

From time to time this fixture department retained great artists and architects to design fixtures, with special reference to the requirements of the many multimillionaires whose orders for fixtures for a mansion would often run up to $50,000. Among the great architects who struck out in the early days notably superior designs for fixtures for electricity only, were Richard M. Hunt, who made the designs for two houses for W. K. Van-

derbilt, McKim, Mead and White, James Brown Lord, Ernest Flagg, George B. Post, Shepley, Rutan, and Coolidge, and many others, east, west and south.

A great many good ideas about designing fixtures were brought to us by the agents in the field. Few of these men knew how to draw, and the few who had been trained in mechanical engineering had no idea about art; but they were all husky, pushing fellows, and the manner in which they picked up a smattering of art, and rolled off long-winded talks to prospective purchasers about all the schools of design, was enough to make the oldest men in the decorative art lines sit up and take notice.

One of the best men we had is now the head of a great electric light and power company in the West. Before entering the lighting business he had been the principal of a classical school, and his manners were Chesterfieldian in the extreme. As a speaker he outclassed most of the professional after-dinner speakers of the time. We used him to open and close negotiations for big contracts. He never lost a big state capitol or city hall lighting job while he was with us. He was the last agent to get into the field to estimate on the great Capitol Building at Austin, Texas, having been detained on a large undertaking in Chicago. But when he got before that body of commissioners at Austin, and told how he proposed to weave the symbolism of art into the fixtures, and make every chandelier an object lesson in instilling love of the Great Lone Star State into the hearts of all who surveyed their beauty, he knocked out all competitors, and was then and there made an honorary member of the Old Texans' Association,—and he deserved it, for he had made a profound study of the history of Texas, and brought out in his address in presenting fixture design the wondrous story of the defence of the Alamo. The laconic inscription which Texas afterward placed on a tablet at the Alamo at San Antonio, "Thermopylae Had Its Messenger of Defeat: The Alamo Had None," was first uttered by that electrical engineer in the course of his presentation of fixture designs, in which as a design for each stalactite and globe he had used the Lone Star of Texas. In another southern State he obtained a large contract because of his familiarity with the history of the State, and his adoption in fixture designs of motifs that were based upon the palmetto, magnolia and japonica trees.

It was fortunate for the electrical engineering science that at that time so many well educated men from other professions went into it, because they were able to speak and write intelligently in overcoming the many strong prejudices that existed against electrical lighting, and which prejudices were made a part of the stock in trade of the host of alert gas men who fought the new science step by step. By the end of 1886 the art of designing electric fixtures was a highly specialized art department. By that time three or four gas fixture makers began to make a few patterns for the electric light. But they one and all looked upon the electric light as a novelty that had no strong bottom, and that therefore the business would pass away. About that time the estimable Mr Archer V. Pancoast, now a large owner of electric lighting stock, told me that he had just decided to make a few electric brackets and chandeliers, but that he did not think the business would amount to much. At that time he was the head of the largest gas fixture manufactory in America, and had almost half a million dollars worth

of fixtures on hand. Until four years later, his electric lighting fixtures were kept in a small room that was opened only to electricians and their customers, as it was good business not to let the great captains of the big gas lighting companies see that the firm was making goods for "the enemy."

About the year 1889, the country's total annual output of electric lighting fixtures amounted to $1,000,000, of which the corporation of which I was an officer, had made almost three-fourths. The fact was published in an architectural paper and was commented upon by several gas lighting journals as an indication that the new lighting method was getting ahead rapidly. A few days thereafter, I had occasion to call upon the learned and able Mr. Harrison B. Gawtrey, President of the New York Consolidated Gas Company. He mentioned that he had read with surprise that the business of making electric light fixtures amounted to a million dollars a year, and then he said that on the previous day he had gone to see a new office building in lower New York, which was the first structure built to be lighted with the incandescent service only. The owners had rejected the idea of using combination fixtures, and had insisted upon putting in two independent sets of engines and dynamos to ensure a reliable service. Mr. Gawtrey then said: "I have made up my mind that electric lighting is to become a vast industry, and that it will be politic to bring about relations with the industry so that gas companies can supply both kinds of lighting, and to that end I am going to send my son Louis to learn the new business." This son is now a great factor in electric and gas lighting corporations.

Much of the early lighting by means of incandescent fixtures was designed to illuminate the principal rooms in high-class hotels, restaurants, cafés and fine retail shops. This work kept the fixture designers in close touch with decorators and architects, and was highly educative. Our own offices were most magnificently decorated by the greatest artists in the country. One room was in Italian Renaissance, another in Louis XIV, two in Empire, one in Flemish, and two in English colonial. At night the whole building in Fifth avenue, New York, was illuminated by the lights in several hundred fixtures, all gold, gilt or silver plated.

Sometimes an intending buyer would be so crushed, as it were, by the magnificence of the place, that he would exhibit indications of "going over to the enemy," as we used to phrase it; that is, decide not to wire and fixture for electricity, but to put in gas. At such times a rough and ready salesman was put in touch with him to take him over to the factory, and there amidst the smoke and din of the disciples of Tubal Cain, such a man felt more at home, and would place his order. But the velvet pile carpets, damask hangings, and figure painted walls and ceilings served well to obtain business from architects and the rich.

The only caller who ever cursed the show rooms as "fit only to serve as a ball-room for the Four Hundred," was a Bostonian, who was about to fit up the finest café in that city. Our Boston agents had written us that he wanted the best articles to be had, and that they must be original. In due time this man came to the show rooms with two well-known electrical engineers, now prominent in Boston. He was not favorably impressed by the stock patterns, and the designs struck off for him by our French, German, English, and American designers, which he pronounced "N. G."

One of our local agents took the man around to all the best lighted places in New York, but all to no purpose. He kept on saying that he wanted "something all American, and nothing foreign." He was then brought to my office, and when I asked him why we could not suit him, he said: "See here, you show me a lot of stuff that is Italian, and more that is French, and a lot that is Dutch, and then some of this here Empire stuff. Now, Napoleon has been dead a long time, and these French kings have been dust for centuries. Why do you keep on copying things that they liked? Give me something that is Yankee through and through." I knew only one place that was Yankee through and through, and that was the miniature lamp decorative department of the General Electric Co., at Harrison, N. J. I took the Bostonian out there, where it so happened the force was working on some designs for lighting the great soldiers' and sailors' monument at Indianapolis. There was also in process several kaleidoscopes which by the revolution of colored lamps, produced superb effects. "This is straight American goods," said the Bostonian, "and these are just the kind of ideas that I like—novel, good and all Yankee style." On returning with our friend to the office, the thought crossed my mind that a few months before an artist from Cape Cod, while on a drunk in New York, had come to the office to raise a loan with some electro-deposition oak, maple, and other leaves of trees as security. These leaves were fished out of a bin and shown to the Bostonian. "These," said I, "are the work of a descendant of a Pilgrim Father. He took the green leaves from the trees, brushed them lightly with varnish, then dusted them over with very fine plumbago, put them in an electro-plating vat, turned on the current, and in this way these metal leaves were made as true to Nature as is possible." This idea the Bostonian considered excellent as the motif for a ceiling decoration, with a small incandescent lamp affixed to the center of each metal leaf. That was the way in which the art of electro-deposition was applied to the art of electric lighting.

While during these early years art and science were going hand in hand, at the same time there were contractors in the lighting business who had no sense of art or science, and whose blunderings and incompetency were hurting the business. It was difficult for us to make some of our customers among the electrical contractors who had no knowledge of science or art, understand that, in place of asking us for a trunk full of designs to be used in hit or miss estimating, they should send us a statement of the requirements, signed by the architect of the structure, and that a design that might answer for a beer saloon was not suitable for a rich man's mansion, or a fine church. At one time we had out among contractors designs which had cost the corporation upward of $200,000. Of these few ever came back, and of those returned, most were greasy and covered with marks of unclean hands. The corporation with which I was associated expended twelve million dollars in building up its industries to a point where a new dollar was received for an old one. Of this vast sum, not less than one million dollars went to pay for laying the foundations of the art of making and installing fixtures. Those pioneers sowed, but few of them reaped. Other men entered into the reward, in accordance with the natural laws that make it impossible for the creators of a new industry to reap profits commensurate with their labor and outlay of capital.

Theory and Technology

Plain Talks on Illuminating Engineering

By E. L. Elliott.

XI. Art Applied to Fixture Design

We have already stated that the illuminating engineer, in addition to his other numerous qualifications, must have some appreciation of the principle of decorative art. The flagrant and crying abuses in the scientific and economical phases of illumination have naturally had the first attention; but the anomalies and transgressions of the canons of art are no less common, though not so glaringly apparent. The duty of the illuminating engineer will have been technically fulfilled if the illumination produced is of the requisite quantity, quality, and economy, regardless of the appearance of the apparatus by which it is supplied; but if the installation is ugly in appearance the technical excellence of the results, no matter how great, will not condone the sins against art.

We have also stated that there is a very sharp distinction between pure and applied art. Pure art exists for its own sake alone, and comprises graphic art (painting and drawing), plastic art (sculpture and modeling), musical art, and literary art. Applied art exists only for the sake of that to which it is applied. Its sole purpose is to render that which is useful and necessary pleasing to the aesthetic sense. There are a few well-defined and undisputed principles upon which all applied art rests, and which, being based upon science; do not require an "artistic temperament" for their comprehension. While the illuminating engineer cannot reasonably be expected to be an artisan in the creative sense, he should at least be an intelligent critic of art as applied to lighting installations.

Let us now proceed from the general to the particular, and examine the fundamentals of applied art, and see in what manner they effect the design of lighting fixtures.

First: *Decoration must never interfere with use.* A clock face put on the bottom of a frying pan furnishes a vulgar example of the transgression of this rule. How could you fry bacon and eggs in such a utensil? One of the commonest infractions of this rule in fixtures is the use of dishes under gas and electric lamps. Fig. 1 shows an electric fixture thus equipped. This is simply a relic of the use of candles, and shows how persistent is the servile imitation of antiquated forms. A dish under a candle is a necessity, in order to catch falling grease. The cheapest tin candle-sticks had such dishes, which had no more claim to being ornamental than has the spout of a tin tea-kettle. In the case of candelabra and chandeliers, which were legitimate objects for decorative art,

FIG. 1.

these drip cups were given such ornamental shape and decoration as they might receive without interfering with their useful purpose. When gas supplanted candles, the candle was imitated by an opal glass tube having the gas tip at the upper end, and the saucer underneath; and this has passed for decorative art unto this day. Dexterity in imitation may create a certain kind of admiration; but imitation is not art,at least, not a high order of art. The well-spring of art is a creative imagination; and if the source be muddy the stream will never be sparkling. "Still life" paintings, though they may be the very images of the objects copied, the cleverest of parodies, and musical compositions simulating thunder storms, are still very low in the scale of true art. The use of the imitation candle in gas fixtures therefore is an admission of poverty of imagination and creative ability on the part of the designer. In the case of the fixture shown, however, there is not even the excuse of imitation; there is nothing to even suggest a candle. The brass dish under the lamp socket is simply a nuisance; it has no real or apparent use, is not beautiful in itself, but on the contrary completely shuts off the light below, and interferes with turning the key on the lamp socket. The globe in the center also exhibits another type of the misconception of ornamental construction, though not in so exaggerated a form as is often found; the globe forms an unnecessary obstruction to the passage of light in its most useful direction.

Metal work overlaying globes and shades is another form of faulty decoration, of which Fig. 2 is an example. The motive of this particular design is obscure, as is the light which it delivers. Perhaps it is intended to represent a lantern hung up on the arm of the bracket. But the lantern is strictly an out-door device and as out of place for permanent indoor use as an overcoat or umbrella. Perhaps it is intended as a sort of puzzle, like certain Chinese carvings, the question being, how did the glass get inside the iron framework? While this example is an aggravated case, the use

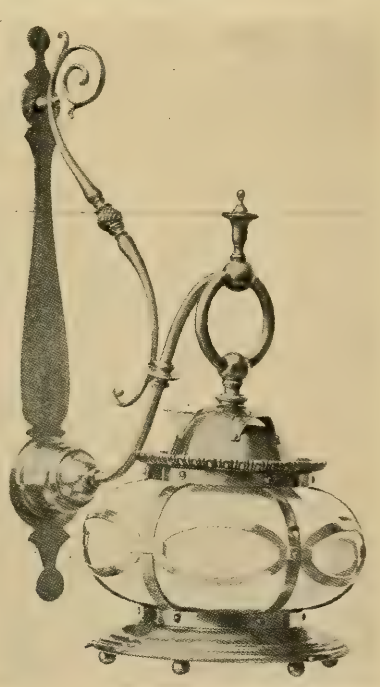

FIG. 2.

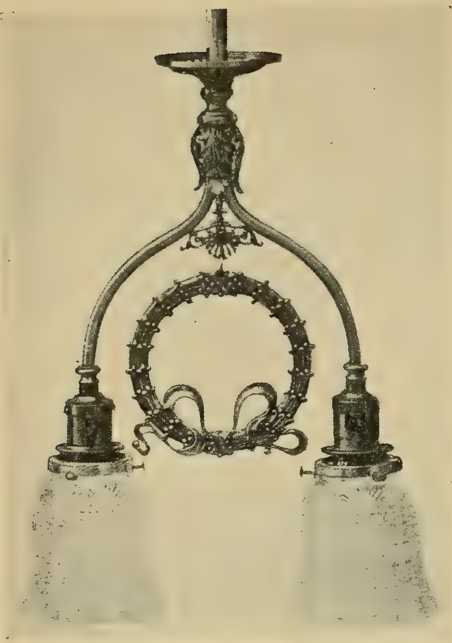

FIG. 3.

of filagree and other metal overlaying on globes is a common practice. Metal so placed has no excuse for its existence, and is directly in the way of the light; its use is, therefore, contrary to good art.

The first question in regard to a fixture is, then: are there any pieces of metal not a part of the necessary mechanical structure which interfere with the illumination? If so, off with them.

Second: *Every part of the object must have an apparent use.* All addition to the general structure that are obviously superfluous are contrary to good art. The transgression of this principle, in American fixtures, is the rule rather than the exception. Fig. 3 is a simple illustration of such a case. What earthly reason is there for the clumsy metal wreath suspended by a single slender attachment between the two arms that support the lamps?

Fig. 4 will serve to illustrate both the use and abuse of this principle. The right hand side of the fixture is shown as originally designed. The arm is bent into an s-shaped curve, which gives almost the maximum

FIG. 4.

weakness and flexibility instead of strength and solidity, while the ornamental work has only the one point of attachment, and cannot possibly serve any useful purpose. If removed, the structure would not be impaired in the least; in fact, it would be relieved of that much superfluous burden of metal. On the left hand side a slight reconstruction has been made. By attaching the metal ornament to the central support, and also, by an extension of the chain, to the point on the arm where support is most needed, the

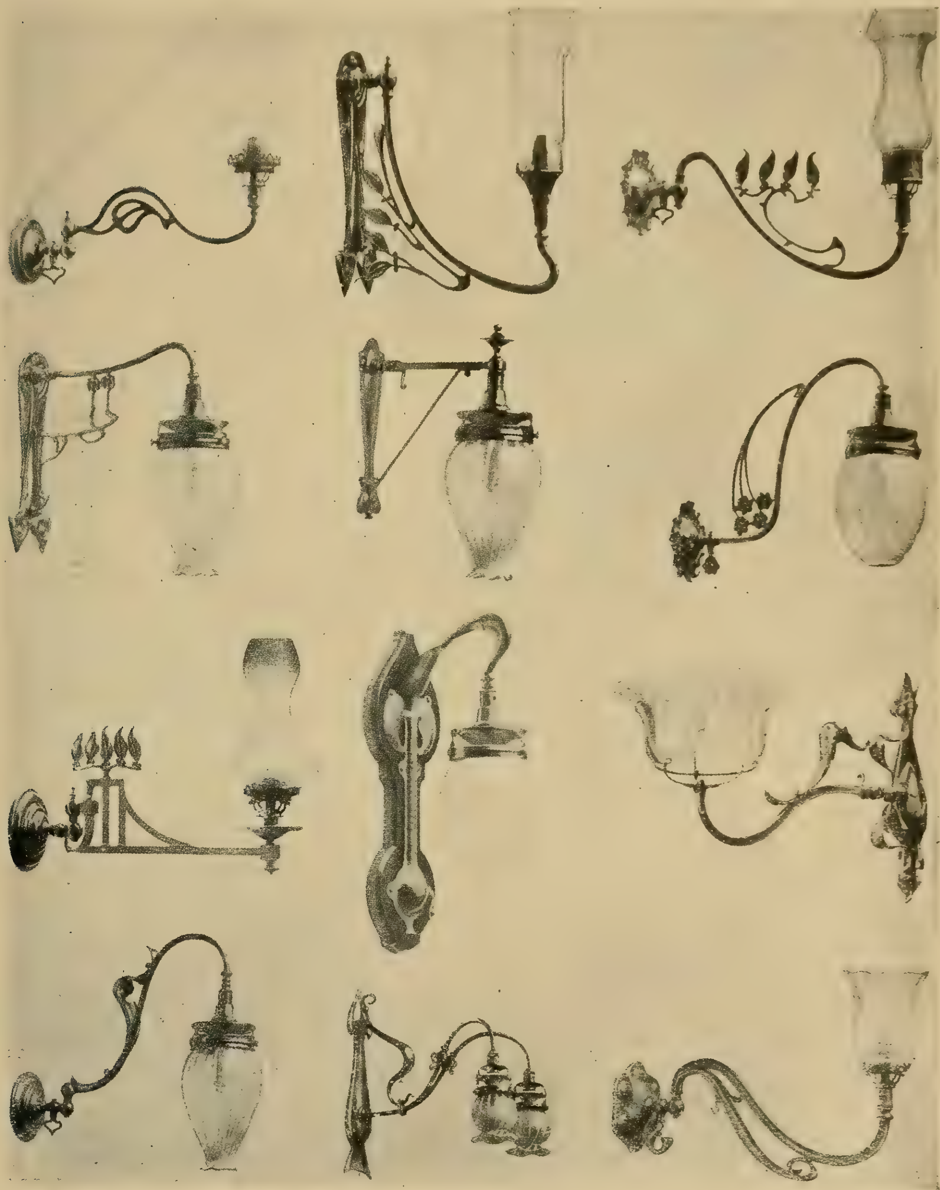

FIG. 6.

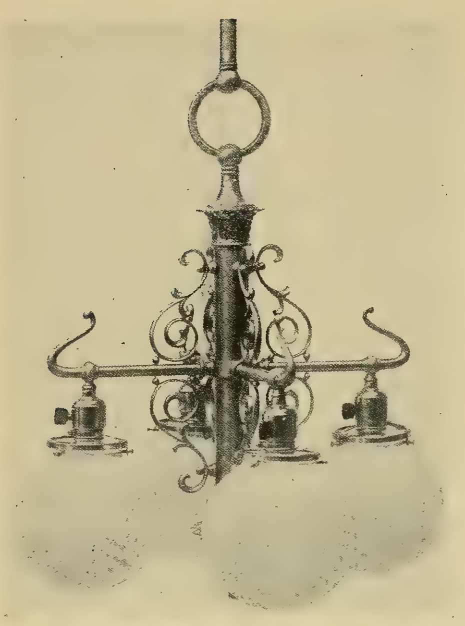

FIG. 5.

whole device becomes, apparently and actually, a constructional unit in conformity with the principles of mechanics: the lamp is supported from two points on the central column, thus affording rigidity and strength. Thus a purpose is given to both the chain and the ornamental casting. Which side *looks* the better? It would be still better if the useless ball at the end of the central support were omitted: put your finger over it in the illustration, and see if it is not true.

Fig. 5 shows a proper use of ornamental construction, the arms being braced from below and supported from above. The artistic effect is good.

Fig. 6 shows a variety of wall brackets for the three different classes of gas burners, taken from the catalog of an English manufacturer. These are all of the Art Nouveau school of design, which has been developed to a far greater extent in Europe than in this country. Observe that in every case the ornamentation is so placed as to strengthen the arm of the fixture. This fact impresses itself upon the mind, though unconsciously; the design at once satisfies, or as the artist would say, "fills the eye"; there is no loading up with metal that has no apparent connection with the construction; in every case the ornamentation is some form of brace for strengthening the arm. Note particularly the very simple bracket shown in the center, consisting of a straight arm and a straight brace, with a very simple wall plate. Notwithstanding its extreme simplicity, the effect is highly artistic. Compare this with the bracket shown in Fig. 7, which is called "colonial" by the manufacturer, though why our ancestors should be accused by implication of such an abberation of art it is difficult to tell. It is evidently intended to express artistic simplicity, but the common goose-neck curve of the arm, and the absurdly disproportionate strength of the supporting chains, convert it into a mere burlesque.

The use of excessive strength, real or apparent, we have already dis-

FIG. 7.

cussed. This is simply one form of adding superfluous parts, and if carried to excess, the effect becomes ludicrous, like that of the extremely overdressed person. There is almost no limit to the amount of ornamentation which can be applied to a woman's gown without offending in this regard, providing only that the ornamentation forms a part of the gown itself, and does not consist in merely hanging on to the fabric various gewgaws and trinkets; and similarly with a lighting fixture, or any other useful article.

Of course, the larger the amount of ornamentation, the more skill and artistic taste is required to manage it. The mere aggregation of parts that, in their proper place, might be ornamental, does not necessarily produce an artistic whole; but even when carried out in the most artistic manner excessive ornamentation on a fixture may be entirely out of keeping with its surroundings, and on the whole it is far better to err on the side of simplicity than too much decoration.

The question of harmony with surroundings, which include the architectural features, the wall decorations, and the movable furniture, is one which bears upon the design of lighting fixtures, and which is more than likely to be given undue weight by the professional decorator. "Period furnishing" is a popular fad at present, which the decorators are working for all it is worth. People whose historical knowledge would fail to enlighten them as to whether Louis XIV was a compatriot of Pharaoh or Napoleon, are naturally desirous of having their houses furnished as a sort of epitome of universal history. By far the larger majority of architectural design is based upon the models furnished by ancient Greece and Rome, and neither of these nations made any use of artificial light worth mentioning, and consequently were not designers of lighting fixtures. Just how the Parthenon, which is the most famous building of all antiquity, was lighted, either by day or night, is still an unsolved question; the general opinion is that it was lighted very little in either way. What is known as the Roman lamp is the only relic we have of the lighting fixtures of ancient times, but even this shows in its ornamentation that the taste and genius which characterizes their architecture was applied to the decoration of this utensil. The lamp was considered an object in itself to be treated artistically in accordance with its specified use.

Colonial architecture, which is also much in vogue, is simply an adaptation of the Greek. As every school boy knows, the most conspicuous feature of Greek architecture is the fluted column, having one of three styles of capital, according to the period in which it was designed. These columns were used for supporting roofs and porticos, and the flutings to bring out the perspective of the column in the glaring sunlight peculiar to Mediterranean countries. The fixture of "classical," or "colonial" design is commonly but an attempt to adapt a structural feature originally intended to support the roof of a temple to sustaining the weight of an electric lamp bulb. The fact is lost sight of that a lighting fixture is not an integral part of the building. It is no more necessary, therefore, to try to adapt the architectural features to the ornamentation of a lighting fixture than to extend them to the chairs and tables, or the crockery and glassware.

The Relative Merits of Direct and Indirect Lighting

By J. S. Dow.

In a recent number of THE ILLUMINATING ENGINEER, attention was drawn to the many points—some of them very important points—on which contradictory views are frequently expressed by illuminating engineers.

It is natural that such disagreement should exist between members of a profession of such mushroom growth, and in which, too, so many different factors have to be taken into consideration. It is the consideration of these many factors which makes illuminating engineering at once so difficult and so interesting.

One of the questions on which very great disagreement seems to exist, is the relative merits of direct, and so-called indirect, or "inverted," lighting, and it occurred to the author that a consideration of the claims of the two distinct systems of lighting would be of value.

In reality, the question at issue is between the use of "point-sources" of illumination, and the use of sources, the radiating surface of which is distributed over a very great area. In the prevalent conditions, both of artificial and natural illumination, we meet extreme instances of both systems, and many shades of systems intermediate between these extremes.

On a cloudless day, the sun resembles a distant point source of light; its rays strike the earth practically parallel to each other, and give rise to clear-cut, sharply-defined shadows.

On a cloudy day, the sky acts like an immense opalescent globe. The sun itself is invisible, but its different rays strike the earth at all possible angles, and no shadows are produced.

One cannot argue, therefore, that Nature intends us to adhere to one system or another. True, statistics assert that the insane are unfavorably affected during long periods of unbroken sunshine, and that suicides and homicides are more frequent during such periods. But this seems to be connected with the greater intensity of certain varieties of radiation, rather than the manner in which the radiation is distributed.

Under artificial conditions of lighting we usually cannot help making use of diffused illumination to some extent. Solitary arc lights in the streets may resemble point-source-lighting, and, being so near to the earth, the lengthy, sharp shadows which are thrown by them are a source of inconvenience in traffic. But in the lighting of interiors we almost invariably utilize the light reflected from the walls and ceiling of a room, in addition to the direct rays from an illuminating source of comparatively small radiating-area.

One of the first aspects of the question which naturally occurs to the illuminating engineer is that of efficiency. In some cases, where the walls and ceiling of a room are necessarily dark in hue, the use of indirect systems of lighting is out of the question. In other cases, where a cumulation of dust and soot rapidly darken the walls and ceiling, it is inadvisable.

But, granted that a pure white ceiling, which can be maintained in this condition, is available, indirect lighting should prove a very efficient method. We naturally lose a small amount of light, say, 10 to 20 per cent., in diffused reflection from the ceiling, but against this we may set the light absorbed by the use of frosted or other diffusing globes, which are really in-

evitable when the direct rays from a source are utilized, and which, like the ceiling, absorb more and more light unless constantly cleaned.

Moreover, indirect lighting enables us to distribute the light in all directions, and to illuminate all parts of a room with perfect ease, while a certain amount of scheming is necessary to accomplish this equally well by the use of scattered individual units. The tendency of the time, too, is all in the direction of illuminants of greater power and greater efficiency. We see this very distinctly in the present condition of the metallic filament lamps. Inverted lighting, by enabling us to concentrate all our light in one bright unit, and yet to secure perfectly distributed light, scores again.

And we also have to bear in mind the greater cost of installing many small units.

In cases, therefore, in which we are quite sure that we *do* wish to distribute our light in this way, indirect illumination may be said to be able to hold its own, and a little more, on the ground of efficiency.

Many cases will occur to the reader in which our object clearly should be to distribute light in this way. A draughtsman's office, a room in which a large number of clerks are working together, a schoolroom—all these are instances in which light is wanted in equal profusion over a wide area. But other cases will occur in which a strong reading illumination is only required in certain positions. In a drawing room, for instance, we usually require a good local illumination over the tables, but we do not want to produce an equally strong illumination all over the room. A drawing-room is intended primarily for conversation, and most people, it will be found, prefer to converse in a somewhat subdued light. The aesthetic possibilities of the room, too, usually demand a somewhat subdued light, rather than a bright general illumination.

On the other hand, it may occasionally be desirable to brilliantly illuminate the whole room during receptions, and so forth, and therefore facilities for producing additional illumination are desirable.

Again, in a dining-room, the most satisfactory illumination, from an aesthetic point of view, is attained by illuminating the table strongly, but allowing the general illumination of the room to be relatively subdued.

In all such cases, where strong illumination in particular quarters only is desired, inverted systems are at a disadvantage, although they may be useful in conjunction with special local lighting.

From a physiological point of view, indirect lighting has the great advantage of rendering it practically impossible for the retina to receive the image of intensely bright light sources, such as the naked filament of a glow-lamp. It is now a truism to illuminating engineers, to insist on the danger of allowing the direct rays from a source of light to enter the eye. Yet conditions often make it literally impossible to place naked lights so as to illuminate efficiently, and yet never to be directly visible, to any of a large number of people gathered together. This makes it really essential to use a diffusing globe of some sort, and even in this case the brightness per unit area of the source is probably sufficiently great to be injurious.

But, from another point of view it seems to the author that the physiological effect of indirect lighting may be unsatisfactory. The effect of this form of lighting is to cause all one's surroundings to appear "flat," shadowless, and really monotonously evenly illuminated. Now it is natural that

our surroundings should influence our state of mind to a great extent, and it seems possible that this loss of contrast, and play of light and shade, may have a "deadening" and depressing effect on our faculties. It is a fact that the deaf and blind lose in vitality through the lack of the stimulating effect of constantly varying light and sound. And it is the *variation* of light and sound which is of value.

A continuous unvarying sound, such as the drone of an organ on one note, soon proves annoying. Therefore, it seems possible that the absence of light and shade effects, which is a marked feature of indirect lighting, and which householders invariably resent, is not only aesthetically objectionable, but also unsatisfactory from a physiological or psychical point of view.

This objection may seem at first sight far-fetched, but it must be remembered that, in the case of people working for hours at a time by artificial light, the cumulative effect of any small defect, in itself trifling, becomes of importance. Moreover, our knowledge of the physiological side of illumination is admittedly very meager at present, and therefore speculation on such points as this is both legitimate and desirable.

There is a further physiological point which has not yet received the consideration it deserves, namely, the use of strong local illumination in order to attract notice. Our attention is naturally attracted by the objects in a room which are most brightly illuminated. In a carefully lighted shop window, attention may be drawn to certain wares by this means. In a lecture-theater, a church, or a schoolroom, accentuation of illumination in the neighborhood of pulpit or blackboard helps to concentrate the attention of the audience.

The same may even be said of the local illumination of desks and drawing boards in an office. If these are more brightly illuminated than the room as a whole, the attention of the worker is naturally concentrated on his task. If, on the other hand, there are other brighter patches of light, which are constantly coming into his line of vision, as he turns his head, and which he is able to see "out of the tail of his eye," his attention is constantly being distracted.

Yet to carry this principle too far is also unwise. If the local lighting is so strong that the room, by contrast, appears to be plunged in darkness, the eye, whenever it wanders from the illuminated work, receives a positive shock. Iris-diaphragm, and retina alike begin to adjust themselves abruptly to the surrounding darkness. And when the partially dark-adapted eye returns to the brightly illuminated desk, it is called upon to readjust its condition once more.

This constant adjustment of the eye throughout a long day's work cannot be without a fatiguing influence on the worker. We have, in fact, a mild example of the well-known tiring effect of an uncertain, flickering means of illumination.

On these grounds, the author contends that, when concentrated attention on work at a desk is called for, the ideal illumination consists of a subdued general lighting, which may be produced by an inverted method, supplemented by concentrated local lighting on the work. If considerations of economy render this impossible, in the case of great numbers of workers gathered together, we may rely upon the cheaper, but less satisfactory, method of inverted lighting alone.

In workshops, the attention of a hand is frequently concentrated on one tool, which he uses for the same

purpose all day long. In this case the above remarks apply.

In other cases, *e. g.*, packing-rooms, and many laboratories, etc., the worker may be obliged to move to and fro, working successively in different portions of a room. He then requires an equally good illumination at all parts of the room, and his needs will be met by inverted lighting.

The absence of shadows, characteristic of indirect lighting, will also be an advantage.

This absence of shadows is, rightly, often referred to as one of the chief merits of indirect lighting. It enables a man to work in any part of a room without the risk of casting a shadow over the work he is trying to examine.

Unfortunately, the method is difficult to apply in many cases where this absence of shadows would be invaluable. In street illumination, for instance, our present system of spacing concentrated lights about the streets is admittedly very unsatisfactory. It is almost impossible to place such lights so as to never come into the line of vision of those in the streets, and the sharp shadows which they cast are frequently confusing.

Yet it is difficult to see how we can apply indirect illumination, properly understood, to street lighting.

We may improve matters by the use of diffusing globes, by using sources of light like the Moore Tube, in which the light is spread over an extensive light-yielding area, or breaking up our lights into small units, but what we really require, a shadowless source with absolutely no "dazzling" qualities, is not attainable just yet.

Yet, in some cases, this very "shadowless" quality of inverted lighting is a disadvantage. There are certain classes of material which really owe their visibility to the shadow thrown by them.

In textile works, for instance, where we may have to deal with masses of woven or knitted material, and where the worker is called upon to recognize the nature of the surface and the quality of the material, inverted light, must, one would suppose, prove unsatisfactory, for it casts no shadows, and it is only by the shadows cast by small projections in the woven fabric that we recognize their existence.

Ornamental carving and engraving come under the same heading. In both cases we are dealing with irregularities in the surface of a material, and we require a very small "point-source" of light in order to bring out these irregularities.

A compositor, who is obliged to distinguish quickly, and select type from their respective piles, and, possibly, a watchmaker, would also prefer illumination from a point-source.

In all such cases, where the play of sharp shadows is relied upon in order to distinguish minute objects, differences in texture, or irregularities in surface, inverted light is at a disadvantage.

But it is when we come to the aesthetic side of illumination that inverted systems of lighting prove to be most unsatisfactory.

For the charm of a beautiful interior often consists very greatly in the play of shadows around pillars, friezes and alcoves, and in the half-revealed recesses of subduedly illuminated corners. A brilliant, even, illumination, which reveals every corner of a room at a glance, is, artistically, most undesirable.

Yet the other extreme system—illumination from point-sources—is also rightly condemned for general use on the ground that sharply defined shadows do not yield themselves to artistic effects. What is really required is illumination by judicially placed and

well-diffused sources of light, yielding shadows—but soft ones. Nevertheless, even "point-sources" may have an artistic local application for the illumination of very minute, *fine* carving, friezes, and so forth, the adequate display of which demands the production of very sharp shadows.

Finally, it may be pointed out that, although the great intrinsic brilliancy of most modern illuminants renders the partial concealment of them both advisable on artistic grounds, and necessary on physiological ones, yet the sacrifice of efficiency entailed by surrounding them with diffusing and colored shades, so as to tone down their brilliancy, may invest them with a new artistic value.

In short, where economy is not of great consequence, we may use sources of light for the production of artistic effects, irrespective of their illuminating value, and place them where they are directly visible to the eye.

To sum up, we can only conclude once more that the relative merits of direct and indirect lighting can only be decided by the conditions of the special case of illumination with which we are called upon to deal.

From an aesthetic point of view, the indirect system is frequently open to grave limitations, if indeed its use is not altogether inadmissible.

Where aesthetic conditions can be ignored, and utilization and physiological conditions are paramount, its advantages are great. Yet, even in this case it will be found to be probably inapplicable to certain special purposes, and the most perfect result will usually be achieved by suplementing indirect lighting with a certain amount of local illumination, and so securing the advantages of both systems.

THE BEACONS.

The afterglow fades in the west
And to the harbor's quiet breast
  The fishing boats come home.

Their anchors cast, they gently ride
Upon the noiseless, turning tide,
  With bows that stand to sea,

And thro' the swiftly gath'ring dark
I watch a tiny, wav'ring spark
  Creep slowly up each mast.

They swing and sway with moving stream,
But ever steady is their gleam
  Upon the darkling deep.

Ah! little beacons in the night,
Mayhap your faithful fires will light
  Some storm-stayed sailor home.

Claribel Egbert.

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The Future of Gas Lighting

The vocation of prophet has always been beset with numerous pitfalls, especially "in his own country." Nevertheless, prophecies still continue to be made, for the reason that they are always exceedingly interesting to the prophet, and occasionally contain some germs of thought that are worthy of cultivation. The occasion of the meeting of the Gas Institute, following the hundredth anniversary of the introduction of gas as a commercial luminant, naturally inspires the inquiry, What will the next hundred years develop in gas lighting?

The introduction of illuminating gas marked the definite close of the dark ages, literally speaking. Previous to this period there was no public lighting which could justly be called illumination. The progress that has been made within the century in the production and use of artificial light is a fair measure of the general progress in science and art during the same period,—a progress that has been so rapid that it has created a new heaven and a new earth. Amidst all the wonders of modern life it is doubtful if any single one would more profoundly impress our ancestors of a hundred years ago, could they assume their physical bodies again, than our present lavish use of light, both public and private. To say that the next hundred years will witness as great an improvement in this respect, is an easy and perhaps safe, prophesy; but to conceive what illumination will be when developed to such an extent would tax the most fertile imagination.

But to leave this purely speculative view and return to matters that more closely effect us: What is to be the position of gas illumination in the near future?

Unquestionably gas lighting is being driven to the wall, in this country, by the electric light. The reason for this must be sought in the conditions which at present govern the financial world, rather than in the relative merits of gas and electric illumination. As a luminant gas more than holds its own in Great Britain and France, and is fully holding its own in other parts of Europe; and this cannot be attributed to any lack of appreciation of good illumination on the part of

Europeans. The simple fact is, that in this country we have fulfilled almost to the limit the truth so admirably expressed by the great English engineer Stevenson, that "where combination is possible competition is impossible." Certainly nothing is more possible than the combination of gas and electric interests; and where this combination has taken place economic conditions favor the largest possible use of electric current for lighting, with a corresponding diminution in the use of gas lighting. The average American is too busy to argue and investigate minor matters, and in such cases takes what is offered him, especially if it has the advantage of requiring less personal care and attention; and with the advantage of convenience, which the electric light undeniably possesses, skilfully presented, and the advantage of cheapness possessed by gas passed over in silence, the acceptance of the newer luminant is a foregone conclusion. The advantage of cheapness, however, is one that cannot be wholly damned, even by the faintest praise; and notwithstanding the recent remarkable improvements in efficiency in electric lamps, this advantage with gas seems likely to continue, even if in a somewhat less marked degree.

By relying solely on the advantage of cheapness, gas has been forced into the position of a second-class luminant, and this fact in itself is the most serious obstacle to its future progress.

To brand a commodity as "cheap" is to "queer" it in the eyes of the average American. As a matter of fact, there is scarcely a single case of electric lighting, in which equally good results, so far as illumination goes, could not be produced by gas, and in most cases at far less cost; but to light with gas is to use a "cheap" luminant, and the American will have none of it. For this condition of affairs those responsible for the management of the gas industries are to a considerable extent to blame. They have rested complacently on their oars, relying on the very great advantage in price to carry them along; while the electric interests have set full sail to catch the winds of popular fancy for more pleasing effects, and have thereby left their brethren of the gasometer as hopelessly marooned as the "Ancient Mariner." To such an extent has electric lighting surpassed gas lighting in this particular that it is doubtful if the latter can ever overcome the handicap.

It would be interesting and highly instructive to see what could be done toward rehabitating gas as a first-class luminant by the application of the same quality of energy, progressiveness, originality and perseverance in presenting its possibilities to the public, that is displayed by the majority of central stations. There are still a considerable number of towns in which the gas and electric interests are independent, and each of these offers an opporunity for such a trial, and incidentally for the successful leader to gain national distinction in the illuminating industry. Unless such an effort is made more or less generally, there seems to be no other prospect for gas lighting than to gradually lose ground until it becomes a mere relic, like the candle of the present time.

The manufacturers of gas burners and accessories are not in the least to blame for this decadence in the use of gas lighting. The incandescent electric lamp, which has been the backbone of the electric lighting industry, and the Welsbach gas burner, were introduced simultaneously; and in the twenty-five years since their introduction. the improvements in gas burners

and mantles have at least kept pace with the improvements that were made in the electric lamp.

The fact that an entirely new luminant, the very principles of which were a mystery, even to those most familiar with it; the means of producing which had to be developed from the most rudimentary principles; which was from two to five times as expensive as gas; and which had vested interests of millions of dollars, with an organization that had been established for 50 years, to combat, has within 25 years established for itself an unquestionable supremacy in the lighting industry, is a remarkable phenomenon, and one which is worthy of close study.

One of the most important, if not *the* most important factor in this revolution, is set forth by Mr. Pearce in his entertaining "reminiscences," which will be found in another section of this issue. At the very outset the electrical interests secured the very highest degree of talent which money could purchase, for improving lighting fixtures and lighting installations. Although not given the name, this was in reality the first effort in the line of illuminating engineering.

The truth of the matter is, that the gas interests were over-confident; and while they were belittling the electric light in a spirit of self-complacency, the electrical interests looked into the future, foresaw its possibilities, and while the enemy was asleep executed a flank movement which soon put them in the lead. Unless better generalship is shown by the gas interests, so far as lighting is concerned, they are destined to dwindle into a mere hoard of camp followers, picking up such discarded bits of lighting as the electrical interests may see fit to leave in their trail. There is not, to our knowledge, a single independent gas company at the present time employing an illuminating engineer, or that seems to have grasped the fact that illuminating engineering is a force to be reckoned with. The electrical interests, on the other hand, were alert to the importance of placing this new science on a sound footing from the very beginning, and are thus preparing to reap the full fruits of their first victories.

"The Sacrifice of the Eyes of School Children"

The above is the title of an exceedingly interesting and valuable article contributed to the *Popular Science Monthly*, by Prof. Scott, which will be found reprinted in full elsewhere in this issue. Illumination is, at the last analysis, a physiological process in which the organs of vision, consisting of what is commonly called the eye, and its connecting nerves and nerve centers in the brain, are the active organs. An intelligent idea at least of the general structure and operation of these organs is of paramount importance to illuminating engineers.

To what degree the body may be subjected to physical discomfort in order to fulfil some mistaken idea of art is a question for the individual to decide; but few will knowingly jeopardize so priceless a thing as sight for the sake of the most urgent claims of art. Even if one may be conceded the right of misusing his own bodily mechanism, he certainly has no right to inflict an injury upon those whose physical welfare is in his hands, as in the case of children. To use a lighting device which necessitates strain on the eyes of those using the light, particularly in the case of children, simply because the device "harmonizes with the decorations," or is a "work of art," is a practice no more

defensible than the binding of infants' feet by the Chinese.

The fact that the eye was originally developed for long distance seeing, and that, therefore, all short distance work subjects it to strain, is in itself a valuable generalization; and the inference that the eye should be gradually trained to such work is certainly sound. Reading and similar intensive eye work done by children should be limited wherever possible to daylight illumination; but if artificial illumination must be used, it should be of the best possible quality, and used in the proper manner. There is, of course, comparatively little occasion to use artificial light in school rooms, and yet in the larger cities the general introduction of night classes is increasing the demand for artificial lighting. From the fact that this demand is of recent growth, and that little attention has been paid to artificial lighting on account of its infrequent use, there is all the greater need for a very thorough inspection of all school-house lighting systems by those responsible for their care, and for a thorough over-hauling of such as are found in the slightest degree deficient.

In comparison with the value of sight, nothing else, not even the entire education itself, is to be compared; and to neglect to eradicate faulty lighting, and to install in its place the best system that technical skill can devise cannot be condoned or excused on any basis of economy. The extent to which the eyes of school children are being sacrificed, as pointed out in Prof. Scott's paper, is in itself a sufficient cause for the employment of a skilled illuminating engineer as a municipal officer, with autocratic powers to see that his instructions are carried out. If all the defective school-house lighting installations were removed, it is doubtful if there would be a single installation left to tell the tale. The reform should begin at once, and illuminating engineers can do no greater service than by privately examining such installations and calling public attention in the most vigorous manner possible to any faults that may be found.

Dark Days

The melancholy days are come,
The saddest of the year;—
Of wailing winds, and naked woods,
And meadows brown and sere.

The dark days are coming. Summer, the season of joy and gladness, "the good old summer time," has passed. Spring, that perennial theme for budding poets, is welcome chiefly as the forerunner of summer, the season of light.

"The flowers that bloom in the spring, tra-la,
Bring promise of merry sunshine."

Light is the symbol of happiness and of knowledge; darkness, of ignorance and despair. And light and darkness are far more than symbolical; they are potent influences for good and evil. It is a matter of statistics that more crimes and suicides are committed on the dark days than in sunshiny weather. It is in the spring, with the coming of the long, bright days, that the

"* * * young man's fancy
Lightly turns to thoughts of love."

In the drama, when the villain, after his long pursuit, has finally brought the heroine to her knees in supplication for mercy, does not the scene always take place amid darkness, relieved only by the fitful gleam of lightning flashes? Was not the chamber "dimly lighted" in which Mephistopheles made his nefarious bargain with Faust? "How ill this taper burns," says Cassius; and then the ghost of the coming disaster appears. In this way Shakespeare makes use

of the notion, prevalent in his time, that evil spirits cause lights to burn dimly. "Some love darkness rather than light, because their deeds are evil," says the Scripture. When Byron wished to paint the most gruesome and hopeless picture conceivable of human despair, he wrote his "Dream of Darkness." How often have the last words of the dying been, "It grows dark." Christ, the personification of the resurrection, is called the "Light of the World."

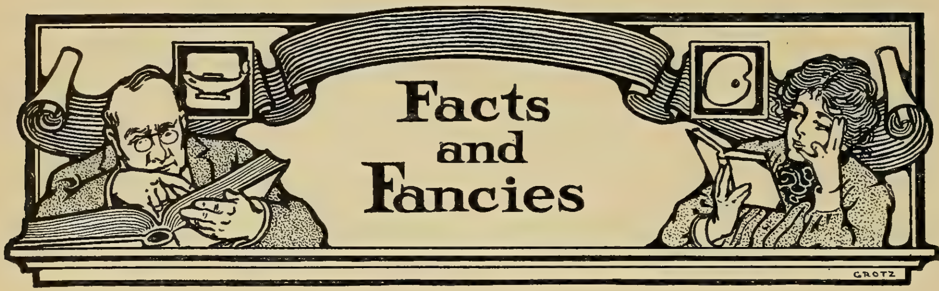
Everywhere and always, both literally and metaphorically, light is life, knowledge, progress, happiness; darkness is ignorance, sin, despair, and death. So Bryant fitly calls the days of gathering clouds and of lengthening nights the "melancholy days." Melancholy indeed would they be, had science and nature not provided a means of dispelling the darkness with lights that vie in brilliancy and splendor with sunlight itself. So the change from summer to winter means only a mutation of time, not a restriction of cheerfulness and pleasure. Even the glories of summer would, like all other pleasures, lose their charm if indefinitely prolonged. The first time that we need a lamp to light the evening meal, is an event, like the first fall of snow, reminding us that another year has swung around. Each season has its own particular beauties and pleasures, but in all seasons light is the one essential. In the gorgeous sunlight of summer we naturally seek life out-of-doors, and just as naturally withdraw to the light of our firesides when the dark days of autumn come.

This fact has been beautifully expressed by Irving:

> There is something in the very season of the year, that gives a charm to the festivity of Christmas. At other times we derive a great portion of our pleasures from the mere beauties of nature. Our feelings sally forth and dissipate themselves over the sunny landscape, and we "live abroad and everywhere." * * * But in the depths of winter * * * the dreariness and desolation of the landscape, the short, gloomy days and darksome nights, circumscribe our wanderings, shut in our feelings, and make us more keenly disposed for the pleasures of the social circle.

But someone will doubtless say, "what has all this to do with illuminating engineering?" To whom we reply: Dear Sir—or Madam, did you never before realize that illuminating engineering mounts to the highest peaks of sentiment, of morality, of ethics, and of science? Have we not often said that the illuminating engineer must be an artist, as well as a scientist, and is not an artist, like a poet, one who "gives to airy nothingness a local habitation and a name?" Is there not something in the profession of the illuminating engineer that is higher and more ennobling than the calculation of foot-candles and watts, of intrinsic brilliancy and efficiency?

The dark days are coming; the lamp, with its summer's accumulation of dust and grime, must be furbished up and put into service. As you brush away the material dust, would it not be well to see whether there is not also some mental dust that is obscuring the clearness of your vision? Minds grow rusty, as well as lamps, and need constant watchfulness, lest they run down in efficiency also. You have had your physical recreation, and let us hope, are, in fact, recreated. The time for study, for thought, for serious, earnest work, is at hand. It has been said that all men act according to their lights. See then that your lights are good; that is the sole article in the creed of the illuminating engineer.



Sight and Seeing in Ancient Times

By Dr. Charles William Super.

From Popular Science Monthly.

When we pass along the streets of our cities and large towns and observe the number of persons between the ages of twenty and forty who wear spectacles; or again, if we inspect the eyesight of the children of our public schools and of the young people in our colleges, we find that a large proportion of the present generation is afflicted with visual organs more or less defective. More than this, there is hardly a person over fifty who does not use some sort of artificial aid to sight. In the German universities the situation is still worse. There, apparently, almost one-half of the students wear eye-glasses. England furnishes a marked contrast; spectacles on the eyes of young men and young women are far less common. The chief reason doubtless is the fondness of both sexes for outdoor life. It is highly probable that our somewhat abnormal eyesight is chiefly due to the abnormal conditions under which we live. The epithet *abnormal* is of course to be understood in a relative sense; it is not strictly applicable to a highly developed stage of civilization. It can not properly be said that the conditions under which the Papuans or the Bushmen live are more natural than those of the residents of London or New York. Each generation is, in a sense, weaker but also wiser; what is lost in one direction is more than made up in another. Still, the injudicious use of the eyes in artificial light and a short range of vision seem to be inevitably imposed upon the dwellers in cities. It is a well-established fact in hygiene that any bodily organ is strengthened by the wise use of it. This being the case, it follows that persons who spend much of their time out-of-doors and in looking at objects afar off, or who use their eyes but little after nightfall, will retain their sight unimpaired much longer than do most people of the present day. On the other hand, failing vision is the natural concomitant of advancing age, so that the number of persons beyond sixty who see clearly with the naked eye is exceedingly small and probably was never very large.

Sight is preeminently the civilizing sense; upon it all progress depends, or, as Oken expresses it, "Sight is the light sense. Through it we become acquainted with universal relations, this being *reason*. Without the eye there would be no reason." The same thought is expressed in the Sermon on the Mount: "The lamp of the body is the eye. If your eye is unclouded your whole body will be lighted up; but if your eye be diseased your whole body will be dark." Not only painting, sculpture and architecture are dependent upon sight, but language also as soon as it becomes the transmitter of experience, whether inner or outer, from age to age. Those peoples that never cultivate speech beyond the point where it is perceived by the ear alone, never advance farther than the primitive stage. But as soon as speech becomes cognizable by the sight, it can be employed to fix the experience and the accumulated knowledge of each generation. It is by means of our eyesight that we are able to learn the thoughts and, to some extent, the feelings of the people of the most distant ages and the most remote regions, almost as well as those of our intimate friends. Yet when we remember that man has left intelligible traces upon the earth, dating back at least seven thousand years, and compare their testimony with the world, say three hundred years ago, we are not conscious of a great advance either intellectually or socially. It is evident, therefore, that important as sight is to man, something more is needed to make him progressive. As soon as the mind becomes fossilized by tradition all ad-

vance ceases. If, on the other hand, we compare the world about A. D. 1600 with its condition at the present day we are constrained to marvel at the advance that has been made. In fact it is not putting the case too strong to say that if by progress we mean man's power over matter, it has been greater during the last fifty years than during all the preceding time of his abode upon the earth. No more striking example of the stationary condition of mankind in certain relations exists than that furnished by artificial lighting. The situation in 1800 was virtually the same that had existed from the earliest times. Torches were used out-of-doors and lamps indoors. Many of the latter found in Grecian and Roman tombs served their purpose just as well as some of those used within the memory of men now living. Friction matches did not become general until about the middle of the last century.

Homer has no word for "color" nor for any of the primary colors. In like manner the term usually translated "black" is very indefinite. It is used of the bronzed complexion of Ulysses and of his henchman, Eurybates; of the ripe grape; of beans; of wine, and of the storm cloud. We moderns would say that it is strictly applicable in the last case only; certainly the difference between the hue of the storm cloud and the darkest complexion of a white man is very marked.

Empedocles speaks of but four colors: white, black, red and pale green. It is hard to believe that the age in which this philosopher lived knew at most only two prismatic colors. It is more probable that he regarded green and blue, and perhaps some other colors, as derivatives from these and therefore not entitled to separate enumeration. According to Democritus, there are but four primitive colors, from which all others are formed by combination. He seems to have regarded blue and green as variants of black. Aristotle thought there were only two primitive colors: light or white and black or dark, and that all others were produced by a mixture of these. Wide as this is from the mark, it shows a tendency to simplify natural phenomena, though it would doubtless be going too far to suspect in this belief an inkling of the composition of light. In the Old Testament four prismatic colors are mentioned, three of them very often and yellow four times, three times in Leviticus and once in the Psalms. In the former, it is used of hair; in the latter, of gold. As the Hebrews were surrounded by nations that had made great advances in technical skill, it is probable likewise that all of them had made greater advances in the discrimination of colors than the Greeks.

The fact that the ancients habitually speak of only four colors is almost proof positive that they did not discriminate more. In addition to the evidence already cited, there is to be added that of painting. What is known of the art of Polygnotus, the earliest of the distinguished painters of antiquity and a contemporary of Pericles, leads to the conclusion that he used no greater number, according to the ideas of his time. Like all early painters he worked on terra-cotta vases and on walls, not on canvas. It seems highly probable that throughout antiquity no distinction was made between orange and yellow, nor between indigo and blue, nor between the darker colors that shade into black. Many of the lower races, both at home and abroad, share this defect. Both have also the same liking for what is gaudy and striking. It is probable that the fondness for "loud" colors is a species of survival that may be studied in children and in persons that are color-blind. The latter defect is a species of arrested development, and being an organic defect can not be overcome. On the other hand, some primitive races are reported to exhibit a very acute color-sense. This mental condition has likewise its analogy among children, some of whom are indifferent to colors, while in others the color-sense shows itself very early. At any rate, modern analogies will not enable us to decide the question for or against any people of antiquity. Two theories have long been held to account for the poverty of terms to designate colors in remote times. The one most in harmony with the evolution hypothesis is that the color-sense has followed the general law of development; the other, that primitive races perceive colors as clearly as we do, but that their languages lack words to designate minor differences. Color-blindness has no connection with mental power in general. It is well known that the celebrated physicist, John Dalton, was not capable of distinguishing more than three colors. Many similar cases are on record. This defect has become known as daltonism or achromatopsia. A more correctly constructed compound would be chromatuphlosis. However, technical terms often lead the philologist to express the same opinion of them that the devil is said to have used of the Ten Commandments, "They are a queer lot." In the language of the Psalmist,

"They are fearfully and wonderfully made."

It is generally held that the first mention of magnifying glasses is found in an Arab writer of the eleventh century. Roger Bacon speaks of glasses that correct refraction. The epitaph of a certain Salvinus Armatus in Florence names him as the inventor of spectacles, although it is said of the monk Alexander of Spina, that he made use of eyeglasses. In the year 1488 makers of spectacles are mentioned in Nüremberg. There is a passage in Scott's "Quentin Durward" that represents Lord Crawford with spectacles on his nose, and the remark is added that the invention was recent. That artificial aids to sight are modern is also rendered probable from the lack of a word inherited from antiquity to designate the apparatus.

The reading habit is essentially modern and may be said to date from the rise of periodicals, comparatively few of which are more than half a century old. The invention of spectacles and that of printing were very nearly coeval. Until that date literary instruction was largely a matter of dictation, repetition and memorizing, as is still the case in many parts of the world. Among the ancient Greeks and Romans the memory was trained to a far greater extent than with us. In the literature of the former there is constantly evident a sort of distrust of the written page. It could not reflect the vivifying power of the living voice. It seems to have been a common thing for Greek youths to learn Homer by heart, huge as the task would be to us. Knowledge was to be elicited by discussion, by the dialectic method, by question and answer. Intellectual training was almost exclusively rhetorical. Taking into consideration, therefore, the fact that eyes were not needed for the manufacture and use of instruments of precision and that the printed page did not exist, we can easily understand that spectacles were not greatly missed.

The Value of a Lightning Flash

An ingenious scientist has spent some considerable time in computing the probable commercial value of a flash of lightning, regarded as a source of electrical energy. His statistics, though at present of little value, are nevertheless interesting. A flash of lightning, one kilometer long, and lasting one thousandth part of a second, represents energy worth $821.80 at the present price of electrical energy in Berlin. This energy corresponds to the industrial production of electricity in all Germany during forty seconds, or that of Berlin during two and a quarter minutes, and it would operate the Berlin elevated and subway an hour and a half at its busiest time, or run an express car at 125 miles an hour for the three hours' trip from Berlin to Frankfort, or light a 32 candle-power lamp for eight years. Yet this is only an average flash, of which as many as 1,000 have been counted in a single thunder-storm. Very interesting, as I before observed, but mindful of a celebrated cookery book's instructions as to the preparation of jugged hare, I suggest —first catch your lightning.—*Electricity.*

Light Paint for Machinery

There is a very marked tendency at the present time on the part of manufacturers of machinery to make a departure from the use of black or dark paint in finishing their product. It has been the custom for a long time to cover the heavier parts of machinery of all kinds with paint or enamel of somber hue and the only variation which seemed permissible was an occasional striping of gilt or some bright color. During recent years a revolution has been going on in the matter of the construction and design of workshops and with it has come the demand for machinery painted some bright color. Not infrequently there is a demand for white, while light gray, buff, and cream color are favorites. The recommendation for this change is that the machine shop presents a much more attractive appearance and that the light surfaces of the machinery are responsible for the reflection of a great deal of light while the black absorbs the rays.—*Scientific American.*

A Novel Use for "Dead" Lamp-Posts

Use has been made of the derelict gas lamp standards in Dublin. Flower-holders have been erected by the New Society in Kildare street on the old posts. Baskets made of cast iron and burnished copper are supported upon the pedestals of disused gas lamps. Growing flowers with green trailing plants fill the baskets and make a splendid display.

CASHIER BOOKKEEPER CONTRACTS ADVERTISING

Commercial Engineering of Illumination

New Publications

HOLOPHANE: Holophane Company, 227-229 Fulton street, New York.

This is the title of the new monthly house organ of the Holophane Company. It is a sixteen-page folder, printed on enamel paper and illustrated with half-tone cuts and cartoons. The superscription on the title page states that it is "devoted to the Holophane system of illumination." A number of "notable installations" are described and illustrated, and there is a special article on "How to Light a Window," which contains valuable engineering data. It is professedly a commercial publication,—it seems to us a little *too* commercial.

The large sale which Holophane glass has reached is the accumulative result of a long and expensive campaign of education, which would have exhausted the patience, to say nothing of the pocketbook, of ninety-nine out of a hundred ordinary successful business men. The positive knowledge that Holophane globes were a thoroughly scientific production, and marked a decided step in the progress of artificial lighting, and therefore must win in the end, was the only solace of their sponsor for a number of years. The general awakening of interest in the subject of artificial illumination, which has culminated in the establishment of a new branch of applied science, can be traced more directly to the educational campaign inaugurated by this company, than to any other single agency; although the campaign was very materially furthered by the efforts of the Shelby Electric Company, whose formation was exactly contemporaneous with that of the Holophane Glass Company. While the ultimate object of both companies was financial gain, the benefits acruing from the exposition of the faulty methods that had been accepted for years, and the inculcation to better practices, are none the less valuable to the public. The very first efforts made toward establishing a market for Holophane glass consisted in having strictly scientific papers, dealing with the subject of illumination in general, and explaining in particular the application of prism glass to the problem of converting light into illumination, written and delivered before various scientific and technical societies; and this educational method is still one of the chief features of the Holophane Company's publicity campaign. We learn from their publication that there were delivered during the past year by representatives of the company, 98 lectures on the subject of Illuminating Engineering, covering every section of the country.

In view of the high plane upon which all of the publicity work of the Holophane companies has heretofore been carried out, we cannot help a slight feeling of regret that their "house organ" should show a tendency to degenerate into the common—not to use an uglier word—style of commercial literature. But it is perhaps unfair to pronounce judgment upon the first issue; at any rate, every one interested in illumination should receive this new publication.

Illuminating Engineering as a Business-Getting Factor

By Richard E. Brown.

The necessity for every electric lighting solicitor to have at least a working knowledge of the principles of lamp arrangement and proper methods of light distribution can no longer be denied or ignored.

The first question put to the solicitor by the prospective customer invariably is "How can I get the most effective lighting for the least money"? and if the solicitor isn't on the job his chances for getting the business are somewhere about the zero mark.

This has been clearly demonstrated in the new business campaign now being conducted by the writer in one of the larger Southern cities.

In the main business section of the city the store windows and entrances have been uniformly illuminated by electric lights, but in 80 per cent. of the stores the entire interior illumination consisted of either gas arcs or acetylene lights. The existence of this condition was largely due to the fact that where the interior illumination was electric, fully 50 per cent. of the stores showed improper lamp distribution. The result was that the customer's bill was far in excess of what it should have been and instead of being a "booster" for the Electric Company in most cases the customer was submitting passively to what he considered an imposition, while in some instances he was raising a good loud shout that he was being robbed.

The effect of such action on the part of existing clients of any lighting company would naturally serve to discourage other merchants from considering the proposition in a favorable light, and the merchants in the city in which this campaign was undertaken were no exception to this tendency, but had the knocking habit good and strong.

Now this condition of affairs might very honestly have been claimed to exist through no fault of the Lighting Company but rather from errors on the part of the wiring contractors, who had designed the layout, and the customers who had permitted the defective system of lighting to be installed. But this raises the question at once, "Should not the lighting company look out for just such possible defects and correct them before the matter goes so far that the customer is forever lost?"

Unquestionably, and it is because the management of the local electric company took this view of the situation as presented by the writer, and met the emergency promptly and efficiently, that within four weeks electric illumination has replaced gas arcs and acetylene plants in a great majority of the business houses not previously on the service and with more to come.

The first difficulty to overcome was the matter of wiring, and in this the customer was met more than half way—the company having their illuminating engineer prepare plans for a rearrangement of the lighting system without cost, and then offering to make the necessary changes free, if the customer would sign a new two-

year contract on a minimum guarantee basis of one hour and 20 minutes' consumption per night per 16 c.p. equivalent installed.

This offer was made to several merchants who were dissatisfied customers and was in every case accepted. The result has been that the lighting efficiency was in every case greatly increased while the current consumption either remained the same or was considerably reduced, but most important to the central station, in every instance some other form of illuminant which had been used in conjunction with electricity was displaced, the correct electric light distribution giving all the light needed and doing away with the necessity for any other form of lighting and at the same time enabling the customer to get a uniformly diffused light with his color values true and clear.

The excellent moral effect on the non-user, by this action on the part of the lighting company, was incalculable and the direct result of the campaign was the taking over, within two weeks of 22 of the principal stores which had used other forms of illumination exclusively for several years, and displacing, in all, about 90 gas arcs and two isolated plants.

Now this could not have been done without the service of an illuminating engineer and a knowledge of the subject on the part of the solicitors coming in contact with the prospective customers, and it is certain that in this instance, illuminating engineering as a business-getting factor would seem to be the "best ever" if values are determined by results achieved.

The stimulus on the soliciting force has been equally marked. With little instruction each individual solicitor has developed a fair working knowledge of the subject and finds that he can give a very fair estimate of what an installation should be and its cost of operation. Such knowledge enables him to figure on a more economical installation than was the case when he was not well informed on the subject, and further, serves to create a most favorable impression on the mind of his prospective customer.

A technical education is not necessary, but a good general idea of color values, height of lamps, spacing between lamps, class of lamps and shades to be used, number of watts per square foot to be allowed for good illumination, and the amount of useful light that would be given if the plan outlined be carried out, would seem essential.

Try it out with your solicitors, if you haven't already done so.

Give them a short course in the primary principles of illuminating engineering and mark me the results secured will surprise you.

Every man of them will tell you that it's the best line of selling talk he has ever used and that it will get the business every time.

The Illuminating Engineering Society

The Elements of Inefficency in Diffused Lighting Systems

Paper read at the First Annual Convention of the Illuminating Engineering Society, Boston, July 30, 31, 1907.

By Preston S. Millar.

DEFINITION.

Diffused lighting, in the sense here intended, is that form of artificial lighting in which the ceiling and walls constitute the reflecting and diffusing media through which the light is transmitted to the plane whose illumination forms the primary object of the installation. By direct lighting is meant the variety of methods in which the lighting of the ceiling and walls is incidental, and the bulk of the light is directed where needed.

For certain classes of work, diffused lighting is credited with features of real or fancied merit. Generally it is characterized by reduced intrinsic brilliancy of light sources and by uniform distribution of illumination, said to be less fatiguing and more pleasing to the eye than direct lighting effects. To secure these advantages, efficiency is sacrificed freely. The extent of this sacrifice depends, of course, upon the nature and the object of the installation, being relatively small where the primary object is the brilliant illumination of ceiling or walls, and large, when the primary object is utilitarian, as for example in desk lighting.

In this paper an endeavor is made to consider the elements of inefficiency which inhere in lighting systems of this character, in most instances basing conclusions upon measurements of illumination intensity. No effort is made to arrive at representative quantitative values, since these vary so largely with local conditions that such data would have to be based upon a series of investigations covering a large number of installations.

LIGHT ABSORBED BY CEILING AND WALLS.

The first element of inefficiency is the loss of a large proportion of the light in multiple diffuse reflection, which is necessary in this system of lighting. This loss has long been recognized, although but little information is available as to its extent even in specific installations. E. A. Norman's recent paper before the New York Section of this Society gave about the only reliable data now available on the efficiency of a diffused lighting system as compared with a direct lighting system.

To obtain material for this discussion, temporary equipments for both direct and diffused lighting were installed in a room of which a plan may be found upon page 326 of Vol. I of the *Transactions* of this Society. The dimensions of this room were sixteen feet by eleven feet, with a ceiling approximately twelve and one-half feet

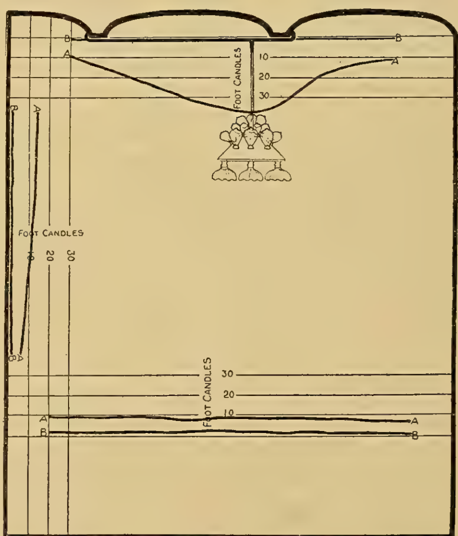


FIG. I.

TABLE I.

	Temporary Installation at Electrical Testing Laboratories. System. Direct.	Diffused.	Harlem Office of New York Edison Company. System. Direct.	Diffused.
Square feet of floor space	176	176	1221	1221
Number of lamps	4	24	84	184
Average mean horizontal candle power	10.2	19.4	16	16
Average watts per mean horizontal candle power	3.53	5.16	3.10	3.10
Total watts	145	2398	4166	9126
Horizontal illumination, average foot-candles	1.02	3.29	5.44	3.84
Foot-candles per watt per square foot	1.24	0.24	1.60	0.51
Relative effect of installation as a whole, Diff./Dir.	19%		32%	

above the floor. The ceiling was finished in light buff color. For the purposes of this investigation the walls were covered with white paper, since diffused lighting systems can be used successfully only where the decorations are of good reflecting power.

In the center of this room, about nine and one-half feet above the floor, was placed a wooden pyramid with a base twenty-five by eighteen inches. Upon the bottom of this twelve incandescent electric lamps, equipped with "Holophane" reflectors, No. 2673 (concentrating type) were wired. On the sides of the pyramid were placed twenty-four incandescent electric lamps, bare. The lamps suspended from the bottom of the pyramid formed a direct lighting installation of which the great bulk of the light was thrown downward, or nearly so, and but little light fell upon the walls and ceiling. The lamps on the sides of the pyramid constituted a diffused lighting system, in which all of the light was directed toward the ceiling or walls, and only such light as was reflected from these surfaces reached points beneath the pyramid fixture.

Fig. 1 shows a vertical section of the room and of the lighting fixture. It shows also illumination curves, plotted from tests, of horizontal illumination on the working plane, vertical illumination on the wall, and horizontal illumination (plane inverted) on the ceiling. The tests were made at points about midway between one end of the room and the lighting fixture, which was near the center of the room. A sufficient number of lamps were burned in each installation to afford satisfactory illumination for reading. The diffused lighting curve illustrates the excessively brilliant illumination of the ceiling and walls, which was necessary if sufficient light was to be obtained near the center of the room.

In this temporary installation tests were made to determine intensity and efficiency of illumination on a horizontal plane thirty inches above the floor. The average results appear in Table I., which shows also similar values given in E. A. Norman's paper, previously referred to.

If the study of the efficiency of the two systems of lighting were to be discontinued at this point, as is usually done, some items of interest and value would be overlooked. In order to determine the relative efficiencies of two systems of lighting it is necessary to consider separately the two prime elements upon which lighting efficiency depends.

The first of these is the efficiency of the illuminants. In an electric lamp this is measured properly by the lumens* per watt.

The second element which goes to make up lighting efficiency is the efficiency with which the light is utilized; that is, the proportion of the total flux of light which is effective on the plane considered.

So there are three expressions of efficiency, all of which are useful, and none of which should be neglected. These are:

* The Standardization Committee of the American Institute of Electrical Engineers has accepted the term "mean spherical candle-power per watt" as a measure of efficiency, but this is only a compromise, since obviously the efficiency of a lamp as a light producer is the ratio of the light produced to the energy input.

The lumen is the unit of light flux. It is the flux of light distributed through unit solid angle. In this country it is the mean spherical candle-power x 4 There can be no reason for continued timidity regarding the use of this most useful unit. Without considering the flux of light it is difficult to obtain a true appreciation of lighting efficiency.

A. Efficiency of illuminants	Lumens per watt
B. Efficiency of light utilization	Ratio $\left\{\frac{\text{Lumens applied}}{\text{Lumens generated}}\right.$
C. Efficiency of lighting installation as a whole	Foot-candles per watt per square foot, or lumens applied per watt.

All parties interested in a particular lighting problem should consider each of these; but more particularly, the lamp manufacturer is interested in the efficiency of the illuminant; the illuminating engineer in the efficiency of light utilization; and the man who pays the bills in the efficiency of the lighting installation of a whole. If any two of these values are known, the third may be obtained for $A \times B = C$. If the illuminating engineer determines the average intensity of illumination on the plane which he selects as the criterion, he can obtain the "lumens applied" by multiplying the average intensity of the illumination throughout the plane investigated by the area of that plane, expressing the intensity in foot candles, and the area in square feet.

A study of this character has been made in connection with the two installations referred to in Table I. The results appear in Table II.

If the horizontal plane is made the sole criterion, it appears that the efficiency of the diffused lighting system in the temporary installation is only 28 per cent. of that of the direct lighting system. This figure is independent of the efficiency of the lamps installed and offers the correct basis of comparison. If these conclusions had been based upon the foot-candles per watt per square foot, nineteen per cent. would have been obtained, while some other factor would appear as soon as the old lamps had been replaced by more efficient ones.

The loss of light in these two diffused lighting systems due to multiple diffuse reflection amounted to about 70 per cent. There are conditions which make this factor too large to be representative, but it is doubtful if this first element of inefficiency ever becomes lower than 50 per cent.

LOSS DUE TO UNNECESSARY INTENSITY AT UNIMPORTANT POINTS.

The second factor of inefficiency is the necessity for providing everywhere on the working plane an illumination which must approximate the highest intensity required at any point covered by the installation. With light which may be subjected to effective control, the necessary illumination is produced where the maximum is required, and efficiency is gained by permitting the intensity to approach a minimum at points where the high intensity is neither required nor desirable. Thus, if for reading purposes an illumination intensity of two foot-candles is required upon a book inclined at an angle of 45 degrees to the vertical, it is necessary in most cases that an illumination of this intensity be available, with diffused lighting, irrespective of the direction toward which the face of the book is turned. When a single light source or a few controllable light sources are used for direct lighting, the reader naturally disposes himself most favorably with reference to those sources, and it is necessary to provide the stated illumination intensity only when the book is placed in the proper relation to the light sources.

Furthermore, in systems of diffused lighting, the body and nearby objects obstruct no inconsiderable proportion of the light which would otherwise be effective. For example, it was found that in the diffused

TABLE II.

	Temporary Installation at Electrical Testing Laboratories. System. Direct.	Diffused.	Harlem Office of New York Edison Company. System. Direct.	Diffused.
Total flux of light, lumens	424	4824	13938	30532
Flux on working plane, lumens	180	579	6642	4689
Efficiency of light utilization	42.3%	12.0%	47.7%	15.4%
Efficiency of illuminants (lumens per watt)	2.92	2.01	3.34	3.34
Relative efficiency of systems; $\frac{\text{Diffused}}{\text{Direct}}$	28 per cent.		32 per cent.	
Sacrificed to secure diffusion	72 per cent.		68 per cent.	

lighting the installation just described, the body of a reader reduced the intensity of illumination on the book by about ten per cent.

INEFFECTIVENESS OF SHARPLY INCLINED RAYS.

The third factor is the ineffectiveness of rays falling at small inclinations upon the surface to be illuminated. With properly located light sources to provide direct lighting, the proportion of light falling upon the working plane at sharply inclined angles is reduced to a minimum—with diffused lighting this proportion is necessarily large at whatever angle the working plane may be placed. The extent to which this factor operates to reduce the efficiency depends largely upon the character of the surface upon which the light falls. The difference between glazed and unglazed paper would probably be marked. Time did not permit of experiments to illustrate this.

HIGHER INTENSITY NECESSARY WITH DIFFUSED LIGHTING.

The fourth factor is the craving of the eye for higher intensities upon the working plane when surrounding objects are brilliantly illuminated. Where the majority of light is directed upon the working plane, the ceiling and walls are of necessity less brilliantly illuminated, and, by contrast, cause the illuminated plane to appear brightly lighted. When the illuminated plane derives its lights from ceiling and walls themselves, these latter must of necessity be more brilliantly lighted and by contrast cause the working plane to appear dimly lighted.

At the time when it was desired to investigate this question, no suitable permanent installation was available. Consequently, recourse was had to the makeshift installation which has been described. In both the direct and diffused lighting systems installed in this room, the wiring was such that any desired number of lamps could be thrown in circuit, and the intensity of illumination at any point in the room could be varied without changing the color of the light.

At various times individuals were brought into this room for purposes of experiment. Each was asked to seat himself in any position and location desired, the object being to secure conditions under which he could read with greatest ease and comfort. No restriction whatsoever was placed, each individual being permitted to choose a location suited to his tastes. When this was done he was asked to hold a section of white newspaper at the angle which seemed to him best. The test plate of an illumination photometer was then placed immediately beneath the paper and parallel to it in such a manner that the paper could be removed and the intensity of the illumination which had been produced upon it could be measured without other change in conditions, the reader remaining in his seat. When the location was being selected the illumination was kept at a low intensity, only one two-candle power lamp being operated. With the direct lighting system the illumination was then raised and manipulated until an intensity suited to the individual's taste was secured. The paper was then removed and the illumination intensity measured. Immediately afterward, the illumination was reduced to the first condition with only a two-candle power lamp burning, and after a short interval the diffused lighting system was tried, other conditions remaining the same. This was manipulated from the switchboard until the desired intensity had been produced and measured.

The investigation was not at all exhaustive, being calculated merely to establish the existence of certain effects which appear from Table III.

TABLE III. ILLUMINATION INTENSITY REQUIRED FOR READING.

Observer.	Angle of Paper with Horizontal.	Foot Candles. Direct.	Diffused.	Diff. in per cent. of Direct.
H. E. Allen.....	46°	2.5	4.7	184
Night Watchman	42°	3.7	4.8	130
Dynamo Tender.	35°	1.85	2.7	144
H. E. Allen.....	47°	3.0	5.3	180
W. S. Howell...	47°	2.95	6.3	217
C. H. Sharp....	44°	3.6	5.0	140
Z. N. Corroz....	49°	2.3	3.1	135
P. S. Millar....	46°	2.75	5.0	181
F. M. Farmer...	49°	2.1	5.0	237
E. Fitzgerald....	49°	2.9	2.6	100
		2.7	4.45	165%

NOTE.—The last value obtained, in which the experimenter required the same intensity of illumination with the diffused lighting system that was desired for the direct lighting system, differs from all the other values. Subsequently it was learned that this observer was influenced by the brightness of the walls to select the stated intensity upon the paper, feeling that greater brightness upon the walls would be annoying and unpleasant.

It appears therefore that in this particular installation, considering the average of ten observers, 65 per cent. higher intensity of illumination was required for reading with the diffused lighting system than was desired when the direct lighting system

was used. Incidentally, it is of interest to note the extent to which observers differed with respect to the illumination intensity which was found to be satisfactory. This is brought out in Table IV.

TABLE IV.

	Direct Lighting.	Diffused Lighting.
Average intensity	2.73	4.45
Average difference from mean, amount	.46	.99
Average difference from mean, per cent	17	22
Maximum variation above mean, per cent	37	42
Maximum variation below mean, per cent	31.5	42
Variation, highest above lowest, per cent	100	142

The conditions of the installations were such that the increase in intensity required for reading with diffused lighting was probably larger than may be considered a representative value. The factor is a function chiefly of the brightness of the walls and of the extent to which the walls and other brightly illuminated objects come within the angle of vision.

It was found that if a placard was viewed at a distance of eight or ten feet, thirty times as much light was required to enable an observer to read it as well with the diffused lighting as with the direct lighting arrangement. In this test large portions of the walls were within the angle of vision, and exercised a powerful influence upon the eyes of the observer with both lighting systems. With the direct lighting system the walls were relatively dark, influencing the pupilary action of the eye so that a low intensity upon the placard appeared satisfactory. With the diffused lighting system they were brilliantly illuminated and so effected the eye that a very intense illumination was required upon the placard.

From the foregoing, the writer has drawn the following conclusions: In diffused lighting systems of the class considered, where the illumination of a working plane is one of the prime objects, a large proportion of the light is lost; that which is not lost becomes less effective; brilliant illumination is produced where it is useless and even undesirable; and conditions are established which create a demand for an unduly high intensity of illumination on objects viewed.

These effects are present in varying degree in all systems in which control of any large proportion of the light is lost. Among such are cove lighting, lighting with skylight effects, tube lighting, and all systems in which the brilliancy of the light source is reduced by diffusing surfaces used without any directing adjuncts. Lighting with large sources is more liable to these effects than lighting with small sources.

The facts indicate the need for devoting as much care to securing suitable minimum intensities, as is generally expended in striving for maximum values. In certain classes of lighting where more light is asked for, the requirements may be served by reducing the intensity of illumination on unimportant objects which are unnecessarily well illuminated. By taking advantage of opportunities to minimize intensities at unimportant places efficency is gained, and, in the opinion of many, good lighting as well.

A New Comparison Photometer

BY DR. CHAS. H. WILLIAMS.

The object of this photometer is to provide a compact and portable instrument for measuring in foot candles, or other units, the light reflected from surfaces, such as the walls of a room, the paper on a desk, etc., in order to determine whether one method of lighting is better than another, whether school rooms are properly lighted, and, in general, to measure the light reflected from an illuminated surface as compared with a standard illumination.

The principle of the photometer is this: The object to be measured is looked at directly through a semicircular opening in the photometer; through another similar opening the light from a small electric lamp attached to the photometer is brought by means of a prism in such a direction that the eye sees a disc of light, the right half of which comes from the object to be tested and the left half from the photometer lamp. If the intensity of the two halves is equal, it shows that the intensity of the illumination due to the object and the standard are equal. If they are unlike, the intensity is reduced on one side by means of a movable photographic film of gradually increasing density, until the two halves of the field are equal. The scale on the film gives the illumination due to the object as compared with the standard.

The photometer is a small thin metal box, Fig. 1, three inches square by one inch deep. At A and B are the two semicircular openings in the box. Over the opening A is a closed tube containing at its further

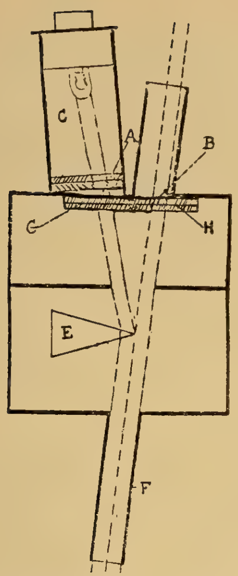


FIG. I. ARRANGEMENT OF THE ILLUMINOMETER.

end a small tipless five volt lamp, and at the other end near the opening a piece of fine ground glass. E is the prism, and F is the tube through which the light and object are seen. G and H are strips of glass about six inches long by one inch wide carrying the photographic films, which can be moved vertically before each opening, so that the light at each opening can be made more or less intense at will. On the handle supporting the box is a contact device so that the thumb can light the photometer lamp when a measurement is to be made, the current being supplied by a small storage battery.

To use the instrument, it is first compared with some standard lamp placed at such a distance from a piece of rough white Bristol board, that the surface of the board receives an illumination of one foot candle. The photometer now has the photographic film before the opening H placed at zero, so that no light is absorbed by this film, the other film before the opening G is moved up and down before the opening until both halves of the field, as seen in the tube F are equal. The lamp of the photometer is then giving on the ground glass an illumination equal to one foot candle of illumination as viewed by the photometer.

In order to measure the illumination of objects in the room, such as the light reflected from the walls, etc., we leave the film at G unchanged in position, and while looking at the object through the film H we move this film until the two halves of the field are again equal and read off, from a scale attached to the film, its position, and from a calibrated chart we can then get the intensity of the illumination of the object looked at in foot-candles.

If the object to be tested has an illumination of less than one foot-candle, we leave the film H at zero, move the film G to a position of less density until the field is equalized, and read from the scale the position of the film to get the fractions of one foot-candle of illumination.

After all the measurements are finished, we again test the photometer by comparing it with the original source of standard light, the film H being at zero. If we find the same position of the film G that was found in the first setting before the measurements were begun equalizes the two halves of the field, it proves that the comparison lamp of the photometer has not varied in its intensity, and this checks up the photometer both at the beginning and at the end of the measurements in a way that is not easily done with other instruments.

With a storage battery of about five volts and a small tipless lamp of the same voltage, we get a light which is sufficiently steady for an ordinary test.

In all comparisons of daylight and artificial light, and with light reflected from different sources, we often get a troublesome difference in color in the two halves of the field; this can, to some extent, be helped by placing a light blue glass in addition to the ground glass in the tube C before the comparison lamp, but it is surprising to see how quickly and with what small errors the setting of the films can be made to give an equalization of the two halves of the field even with differences in color, and this is helped somewhat by the fact that these photographic films are neutral and non-selective in their effect on colors. They are the same films which have been for some time used at the Harvard Observatory in some of the astronomical work.

Where measurements are made of surfaces illuminated by artificial light, the color difference between such light and the photometer lamp is less marked than it is between daylight and the lamp. Street lighting can be measured by holding a piece of white Bristol board normal to the direction of the light at a uniform dis-

tance from the street lamps to be tested, and measuring, with the photometer, the amount of light reflected from the board.

Acetylene

By A. Cressy Morrison.

If the primary object underlying the efforts of the Illuminating Engineering Society is the better utilization of existing illuminants, Acetylene demands attention. Acetylene is so largely used throughout the world that it is generally recognized as one of the common illuminants. Any illuminant which, candle power for candle power, and cost for cost, compares, with advantage to itself, to city gas at a dollar a thousand cubic feet, and which can be generated by an inexpensive individual apparatus, ranging from a table lamp to the generator for lighting of a great institution, a village or a city, commands serious consideration. When it can truthfully be said that, in addition to the commercial advantages so briefly outlined, acetylene illumination closely approximates that ideal which the world has been seeking; is the nearest approach to sunlight yet attained, then C_2H_2 stands revealed a young giant in the field of illuminants, well equipped for the struggle, asking no quarter, and destined by inherent merit to win and hold a conspicuous place.

So, justified by the dignity of my subject, I feel no trepidation in presenting it to this august body, for as liberty is greater than the patriot who advocates it, so acetylene will compel your attention where the individual would not dare ask it.

In March, 1836, Edmund Davey, Professor of Chemistry to the Royal Dublin Society, described the properties of a new gas, C_2H_2, which he had discovered, following this in the autumn of the same year by a more extended paper to the British Association, closing the report with the following remarkable statement: "From the brilliancy with which the new gas burns in contact with the atmosphere, it is, in the opinion of the author, admirably adapted for the purpose of artificial light, if it can be produced at a cheap rate." The announcement attracted profound attention, and from this point a detailed history of the investigations and advances which followed would be too voluminous for the purposes of this paper.

Scarcely a year passed without some step being taken which elucidated the physical and chemical properties, and a list of those who contributed to our knowledge of the subject would embrace many of the greatest names in chemistry and physics. An unusual condition surrounds the birth of this interesting gas, in that, long before its production on a commercial scale seemed possible, its properties were thoroughly understood, its place in nature had been ascertained, and its field of utility anticipated.

With the extraordinary progress of the electrical industry, came the development of the electric furnace. Herein the concentrated energy of the whirling dynamo, hampered by resistance, with heat beyond compare, was to demonstrate its potency by tearing asunder the atoms of numberless chemical entities, and thus make possible new combinations.

By the use of the electric furnace, in the spring of 1892, Thos. L. Willson, working at Spray, North Carolina, produced calcium carbide by the combination of lime and carbon in the terrific temperature of the electric arc in the electric furnace, and in May, 1892, calcium carbide was obtained by Willson in quantities and sent to various scientific friends. On September 16th, 1892, Willson sent specimens of his carbide to Lord Kelvin.

Later, Moissen, working in France, also produced calcium carbide.

Quoting Lewes as to the question of priority, we find that the honor of the commercial development of acetylene belongs to Willson.

"There is not the slightest doubt that the work of Moissen and Willson was entirely independent, and that the Canadian experimentalist at Spray and the brilliant Parisian savant had never even heard of each other, much less of the work they were respectively doing, until certainly after the publication of Moissen's paper in 1894; and it is also perfectly clear that up to the end of 1892 it was Willson, and Willson only, who had made calcium carbide on anything like a large scale, and nothing would ever have been heard of this material on a commercial scale had it not been that he, in attempting to get capital invested in his process, came across several men of sound practical knowledge, whose business instincts led them to grasp the possibilities of carbide and acetylene, and no sooner had these commercial possibilities been noised abroad than others began to try and make capital from them. In France, on February 9th, 1894, Bullier applied for a patent for the preparation of the carbides of the alkaline earths based on Moissen's researches. M. Moissen himself has never

claimed priority in the manufacture of commercial carbide, and, indeed, whilst lecturing before the New York Section of the Society of Chemical Industry on October 26th, 1896, he distinctly stated that the credit of the first production of calcium carbide on a commercial scale was due to Willson, and the industrial utilization of acetylene belonged to the Americans."

Calcium carbide is a substance resembling dark granite, running in various sizes (according to the use to which it is to be put) from egg size coal to the size usually known as pea. The component parts are lime and carbon. Coke, as a typical carbon, is largely used in the production of calcium carbide. The lime must be pure and practically free from some of the usual constituents of lime, which would, if present, appear in the finished product; hence, care in the selection of the source of supply is necessary. The lime and carbon are crushed very fine, mixed in proper proportions, and, in a specially constructed furnace, subjected to the heat of an electric arc.

The amount of electric horse power required for the production of calcium carbide varies, but it has been stated that it takes a horse power year to produce a ton. Under the best conditions, a horse power year will produce somewhat in excess of this quantity.

When the lime and coke are subjected to enormous temperature, said to be above five thousand degrees Fahrenheit, they combine and are removed from the furnace either by tapping, when the molted material runs into ingots, or in a species of rotary furnace the calcium carbide, still hot, is removed in pigs weighing a thousand pounds or more. These are broken by sledge hammers, run through crushers, packed in sheet steel drums, and, for domestic use, distributed one hundred pounds to the drum.

When calcium carbide is placed in water, the affinity of the calcium manifests itself, and the carbon is set free. The carbon immediately forms a combination with the hydrogen of the water, in the form of C_2H_2, which is acetylene.

Theoretically, one pound of calcium carbide will liberate somewhat over five cubic feet of acetylene. Very extended commercial use has demonstrated that the yield of acetylene by calcium carbide is about five cubic feet to the pound.

With the birth of calcium carbide as a commercial product consequent upon Willson's discovery, there arose a series of scientific investigations that the best practical methods of utilizing the new illuminant might be found. The process of generating acetylene from calcium carbide being so simple, the evolution of the gas being dependent only upon placing the carbide in water, the field opened was a very promising one. While the physical characteristics of acetylene had early been studied, its use for domestic or industrial purposes, however, brought into play conditions hitherto unconsidered.

Acetylene, when compressed to liquefaction, occupies but one-four-hundredth of its bulk at atmospheric pressure. The most obvious course of procedure was, therefore, the compression of acetylene into cylinders and its release under pressure regulators, to be utilized at the burner as required. It was found, however, that acetylene when compressed gradually changed its nature, and under heavy pressure became a very dangerous substance. Explosions followed the experiments to carry out this theory, and as a result compressed liquified acetylene is no longer utilized.

Some years were to elapse before a means could be devised for the utilization of acetylene in compressed cylinders with safety. It was subsequently found, however, that acetone, a liquid related to alcohol, would at atmospheric pressure absorb about twenty-five times its bulk of acetylene, and for each additional atmosphere would take up an equal quantity. It was also found by filling the cylinders with asbestos, in the form of discs, that while the entire space was apparently occupied, as a matter of fact 80 per cent. of the space still remained. It is a well known property of gases that they will not explode through apertures of varying sizes, and in the case of acetylene no explosion will transmit itself through a minute aperture.

By exhausting the air from the asbestos in the cylinder and filling the vacuum thus caused with a certain percentage of acetone, it was discovered that an enormous quantity of acetylene could be stored in these cylinders at pressures not exceeding ten atmospheres, and that such cylinders could be subjected to all ordinary and some extraordinary tests with no danger whatever.

This system has been so developed that acetylene is rapidly replacing other illuminants upon the railroads and in yacht lighting, and a conspicuous illustration of the

utilization of acetylene on this principle is in the headlights of locomotives and automobiles, a field in which acetylene is rapidly extending.

While the use of acetylene as above described is interesting and conspicuous, and while the use of acetylene upon railroads is growing with remarkable rapidity, the real use of acetylene throughout the world is in domestic and business illumination, either by means of individual generators or by means of central town plants. There are domestic plants in operation in the United States exceeding one hundred thousand individual units. The number of towns lighted by central acetylene plants is two hundred and ninety.

The development of acetylene for domestic uses was attended by difficulties that were little expected. It is unnecessary in this paper to go into details. It is sufficient to say that the inventive genius of our country has solved the problem better in America than elsewhere, and that, under the supervision of the Board of Engineers of the National Board of Fire Underwriters, adequate automatic safety devices have been developed, which brings this means of domestic illumination to a point of automatic simplicity greater than that of any other illuminant, and it is generally acknowledged that acetylene illumination is to-day a less hazard to life and property than the illuminants which it replaces.

Acetylene is exceedingly rich; so rich, indeed, that its illuminating power is fully ten times that of city gas. Reduced to practical figures, a half-foot burner supplied by acetylene will give greater illumination that a five-foot burner supplied by city gas. The quality of the illumination is unequaled. The spectrum of acetylene is nearer to the spectrum of the sun than any illuminant; so close, indeed, that there is little prospect of further improvement.

The present price of calcium carbide in the United States is seventy dollars per ton. This price is slightly lower and the quality of carbide slightly higher than in any foreign country. At this price, candle power for candle power, acetylene is cheaper than most illuminants. It compares with city gas at one dollar per thousand cubic feet, and so closely approximates kerosene in cost, that, when the trouble of lamp cleaning, chimneys, wicks, etc., is taken into consideration, it is really an economy here.

Acetylene represents the first step beyond kerosene for the country dweller. It is as great a leap in the direction of progress from kerosene as kerosene was from whale oil.

The industry has been developed to a point where the production of calcium carbide is definitely assured. The quantity which can be produced depends only upon the development of water power. The methods of generation and utilization have passed through their evolution, and the burner, which for a long period presented many problems, has now been perfected, so that the rich gas can be burned without danger of carbonization.

The prejudice to a large extent against the new illuminant—a prejudice which accompanies the use of all innovations—has been in a large measure removed. The practical operation of practical plants on an economical basis having been demonstrated, the field for a rapid extension of the industry is therefore apparent to all.

It is these facts combined which will force upon the members of the Illuminating Engineering Society a thorough and careful consideration of every part of the problem which consists in taking this spark of the sun at the burner and so distributing its radiance that the maximum perfect illumination shall be secured.

The first consideration should, I think, be given the quality of radiance. Every illuminant has its special field of utility which no other illuminant can fill. Therefore, as a starting point, permit me to call attention to the fact that color values are normal under acetylene.

In this connection I will revert to the discussion of the "Color Values of Artificial Lamps" before you by Mr. Stickney. A number of sources of light were mentioned by him, but no mention was made of acetylene. In the paper and the subsequent discussion some of the disadvantages of light sources mentioned which are not possessed by acetylene were touched upon. Principal among these was the disproportion in the different colors which go to make up the total of the lights discussed. Sunlight possesses practically the same candle power for each of the primary colors of the spectrum. That is, if a seven candle power beam of sunlight is broken up into its constituents, we would have practically one candle power for each of the seven primary colors. The same would be true of a given candle power of acetylene. This balanced spectrum is a property not possessed by any other artificial light.

Some artificial lights are entirely wanting in either one or the other of the spectrum,

or possess one or more of the constituent colors in great excess of deficit. Take for instance, the low candle power reddish or yellow lights with which we are ordinarily familiar, such as candles, kerosene and gas light. If those are dissociated by the spectrum it will be found that there is very little, if any, of the violet rays in the light, and hence a substance or fabric which possesses a violet color by virture of its ability to reflect violet light, will in the absence of a violet light appear black, while on the other hand, a substance or fabric possessing normally a red color will appear unduly red in a light possessing a disproportion of its candle power at this end of the spectrum. To secure a light with such unbalanced illuminants which consists of an equal amount of each of the different colors and which will therefore approximate daylight it is necessary to determine the value of the lowest member of the spectrum and then eliminate all the excess which the other members may possess. This is mentioned by Mr. Stickney, who suggests the use of a reflector designed to absorb the excesses of certain colors or the use of a screen for the same purpose. For example, take a light which possesses say five candle power in the violet end of the spectrum and one candle power in the red end, with an average candle power of three and a total candle power of twenty-one. To obtain a light similar to daylight it would be necessary by means of a screen to cut out all of the excess light and reduce each to the level of the lowest, which would be one candle power for each of the seven constituents. A balanced spectrum would thus be obtained, but the total candle power would be reduced to seven. Such a plan is very inefficient, even for lights with a fairly well balanced spectrum and is quite out of the question when a light is very deficient in one end or the other. The absorption then necessary to balance the two ends of the spectrum would be impossible. In the absence of any one color it is impossible to balance the spectrum and we have to get along as best we may with unbalanced spectrum, which results in the red and yellow lights which we have been accustomed to through use after sundown for generations. The clear white light of acetylene, which in its primary form as it is emitted by an acetylene flame, has all the colors practically balanced, and hence different colors of substances when viewed by acetylene will have the same value, relation and intensity which they would have if viewed by daylight.

It must therefore be apparent that acetylene has a special field where fine discrimination in color values is necessary. There is scarcely an industrial institution where, in some stage of the process, a thoroughly trained eye is not called upon to judge color. In dye works, printing establishments, lithographers, paint grinding, carpet mills, in testing syrups and molasses, and in thousands of other ways acetylene is as clearly indicated as is quinine when malaria is diagnosed by the physician. Carrying this thought further it will be seen that the operating rooms of hospitals, where other artificial illuminants are apt to distort colors and thus jeopardize the very life of the patient, acetylene will show the tissues of the body in their natural colors, and the surgeon can with unerring judgment perform the operation. In the chemist's laboratory and in the laboratory of the physiologist who is called upon to use the microscope day and night in testing the anemic condition of the blood. In counting the corpuscles, in discriminating between the typhoid germ and the bacilli of the White Plague; in the physician's home, where the examination of the tissues is the basis of his diagnosis; in the operating room and the work room of the dentist —acetylene has a field practically its own.

The optician is to-day called upon to diagnose abnormal conditions of the eyes, using abnormal light. It is a wonder that his work is so accurate. Here, too, acetylene will ultimately come into play; and it is only a question of time when this new aspirant for honors in the field of illumination will be recognized by the Illuminating Engineers as essential to the solution of the problem of proper light in such situations.

The artists of the world select a north light and paint by daylight. Their color values are thus balanced in accordance with the solar spectrum. Their paintings may be judged by the experts, and the medals awarded, in daylight, but the paintings of the world are judged by the great buying public usually under artificial light. With the exception of acetylene, the artist is thus subjected to a great handicap by every illuminant. Though some of the modern illuminants may be skilfully modified by mechanical means and brought to a nearly satisfactory condition, still these means are not usually utilized.

The Illuminating Engineers will do well to consider the value of acetylene in public and private art galleries. The art connoisseurs will certainly appreciate the per-

fectly apparent fact that their million dollars' worth of paintings can be made to look as well by night as by day, providing they invest a few hundred dollars in the purchase of special apparatus to produce an illuminant which is in reality daylight at night.

The country home is now becoming as artistic, and in some respects even more stately in its elegance, than the city residence. There exists to-day in the most artistic minds an appreciation of the fact that in the selection of furniture, wall colorings, and in fact the whole color scheme of a house, a compromise must be effected between daylight and artificial illumination, and that what is perfectly satisfactory at night may be discordant in the day time, and vice versa.

While the illuminating engineers are attempting in every way possible to eliminate the excess of one color or another from the illuminants which they are called upon to use, they would do well to remember that in acetylene at the burner there is this balanced spectrum and that no compromise or other considerations are necessary, and that colors are natural colors under its beautiful rays.

The illuminating engineer is to-day discussing with all seriousness the effect upon the eye, the optic nerve, and in fact dealing with the psychology of glaring lights, and the modification of brilliant units is being carried forward by them on the road to perfection. Acetylene is a brilliant unit, and it, too, will require modification. While its effect upon the eye, candle power for candle power is infinitely less injurious than any other illuminant, it is as unwise to look acetylene in the eye, so to speak, as it is to gaze at the sun. On the other hand, it is literally sunlight, and it cannot be denied that through all the ages the eye of man has been modified to see best by the illumination from Old Sol. This constitutes a harmony of physical adjustment which gives acetylene an immense advantage which the illuminating engineers cannot overlook.

Carrying out this thought of the resemblance of acetylene to sunlight, it may be said that a long series of experiments has been conducted upon the growth of plants under artificial illuminants, and the result has shown that the only illuminant under which plants will grow naturally to fruition is acetylene.

The subtle differences in the spectrum of other illuminants are clearly detected by the elusive chemistry, one might almost say the alchemy, of plant life, and only under acetylene will vegetation grow without abnormalities.

This raises a question which has not yet been worked out, but which will at some time come within the range of those problems which the illuminating engineer must solve, and that is, what is the physical and psychical effect of different illuminants upon the human body, the human mind, and, let us say also, the human soul. This is no far-fetched dream, and it tempts one to say that if growing flowers turn their faces to the sun and acetylene, and attain normal life and growth therefrom, acetylene is apparently well recognized by inanimate nature as a beneficent illuminant.

Acetylene is perhaps stronger in actinic or chemical rays than any other illuminant. The illuminating engineer will therefore at once recognize its great and unparalleled utility in photography. While the photographic studios of the world are to-day using artificial illuminants more and more, the actual amount of acetylene used for such purposes is not great, though it is more economical than the illuminants which it would replace. The time required for taking a negative or developing the prints therefrom is considerably less, and photographic effects are possible with acetylene which cannot be obtained by other means. A better knowledge by the photographers of this combination of utilities will lead to its rapid introduction. The same advantages are manifested in the case of architects and others who are doing similar printing. This, however, while constituting a large field, is supplemented by a still larger practical utility, and that is in the photo-engraving processes, including the three-color printing field. Many photo-engravers are obliged to work day and night by artificial illumination, and the methods now in use are expensive and cumbersome compared with acetylene. In every phase of this industry the illuminating engineer will find that acetylene can be used with tremendous economic and practical advantages.

Acetylene has been very prominently mentioned for use as a standard for illumination. While there are many standards in use there is no satisfactory unit of light. The basis of all illumination is the light emitted by a sperm candle. This has a number of disadvantages which have never been entirely overcome. Before the science of illumination had reached its present stage of development and people were satisfied with low candle power lights of

red color, and were not particular as to the amount, the candle was a very fair standard. At the present day the amount of light has changed until the unit of light is nearer 50 candles than one (having all due respect for the 16 candle power unit of the electrical people). The one candle standard is still, however, adhered to—an arc light of 1,000 or more candle power is still compared to the light of the sperm candle and such measuring in large quantities with a small scale is analogous to surveying land with a six-inch rule. With the increase in the volume of light its color has changed, and now artificial light is very much whiter than was formerly the case. This lends another objection to the candle as a standard, as it is hard to compare the intensity of a white light—such as the arc lamp or incandescent—with the red light of an English candle. The German standard, or Hefner candle, possesses disadvanatges in an even greater degree, as that standard is only 88/100 of an English candle, and is still redder in color. Another difficulty with the candle is its susceptibility to drafts and to ventilation, and being made of spermaceti, which is an animal product, there is no assurance that any two candles will be similar, and that they will not suffer deterioration with time.

A really satisfactory standard of light should possess a large candle power, should be white, should be capable of reproduction by different men at different places, and the standard should be consistent with itself. There is no substance which lends itself to the fulfilment of these conditions better than acetylene. Its color is white, a one foot acetylene flame will easily have a value of 40 candles, the acetylene is produced from a mineral product, which is not subject to decay or deterioration. Acetylene being a definite chemical compound without an admixture of any sort can be produced in a state of chemical purity which would give the same light wherever and whenever the simple conditions necessary for its production were provided. A screen with a hole so arranged that only the central portion of the flame would shine through, thus cutting off the edges and eliminating the error which might arise from different consumptions of gas, could be easily arranged.

It seems rather audacious, perhaps, that with the advent of acetylene for serious consideration by this body, a suggestion should be made that other standards of illumination for estimating candle powers be abandoned and that the adoption of acetylene as a standard should be called to your attention. The necessity for improvement and advance is perhaps more apparent to the illuminating engineers than to any other body, and while the use of acetylene as a standard by which other illuminants should be measured has been advocated by some of our greatest scientists, a reiteration of its claims here can do no harm, and is simple justice to the quality and integrity of the new illuminant. It is probable that this body could carry the suggestion of acetylene as the standard forward to its general adoption—certainly in this country, and perhaps throughout the world. The Illuminating Engineers are in the van of progress, and the improvement of our present standard, whether acetylene be chosen or not, is certainly one of the fields to which they should devote their attention.

The use of acetylene and calcium carbide in other fields, which in this paper must be briefly touched upon, are not without great interest to the illuminating engineeer. The Canadian government has begun the substitution of acetylene for lighting all its buoys, light houses and beacons. It possesses qualities of steadiness, the possibility of burning for months without attention in inaccessible localities, and, it is said, a penetrating power in the case of fog that is unparalleled. With the light steadily burning, it is said that the heat of the generation of acetylene is sufficient to protect the generator against freezing, and acetylene in cylinders compressed in acetone and asbestos suffers no change under the lowest temperatures recorded. The United States government has already adopted acetylene for many light houses and for many beacons, and is now considering its rapid extension.

It has been found that acetylene headlights are an actual economy and a great advantage to long distance trolley lines, and acetylene is now being substituted by such lines for the arc light headlight. Acetylene in this situation has the advantage of burning steadily, whereas, whenever the electric current is cut off, the trolley is left in darkness, and may run for a long distance at great speed without illumination.

The railroad systems are considering the use of acetylene for signals. The penetrating quality of the light in case of fog is here a matter of grave moment, and will be noted by the engineers.

The use of acetylene in power has been suggested, and has recently received a great stimulus by the enactments of the United

States government relating to denatured alcohol. It is found that denatured alcohol containing twenty per cent. of water, if atomized and blown through calcium carbide, will take up enough acetylene to enliven the alcohol and bring it up to the exact standard required for internal combustion engines. Engines using this power have been run for long periods of time, and the success of the process has been practically demonstrated.

A combination of acetylene and oxygen under about one-half atmospheric pressure, used through a blow pipe, produces the highest temperature known to chemistry—a temperature approximating that of an electric arc, probably above six thousand degrees Fahrenheit.

The flame can be produced not larger than a pencil point, and through its means welding is successfully accomplished by literally melting the metal together. It is said that the use of this acetylene flame for cutting the steel girders and wreckage which resulted from the San Francisco fire would have saved millions of dollars. Great steel bridge girders can be melted apart with ease and facility. It is said that a fourteen-inch shaft has been welded. Where the metal is so welded, the file fails to disclose the location of the break. There is scarcely a repair shop or metal working establishment in the world which will not ultimately use many autogenous welding torches combining acetylene and oxygen.

The production of cyanid, which is destined ultimately to supersede Chilean nitrates as a fertilizer, is now in enormous practical operation in several countries. The exhaustion of the soil by the extraction of the nitrates by food plants is taking place so rapidly that, without a source of soluble nitrogen, the world would ultimately be confronted with starvation. The importation of Chilean nitrates during the past year has exceeded fifteen million dollars in value. The exhaustion of the Chilean nitrate bodies, from which a million and a half tons are now removed annually, is dated variously at from ten to thirty years from the present time. No other source of supply is known.

Four-fifths of the atmosphere is nitrogen. By blowing nitrogen through hot calcium carbide, the nitrogen is caught, and in such form that after various chemical processes it can be utilized in cyanamid. Experiments have shown that cyanamid possesses the same qualities as Chilean nitrates and can be used with equal success. The cost of production is such that it can be sold in competition with the natural product.

Therefore, in calcium carbide and the quality it possesses of fixing nitrogen lies the solution of the problem which has confronted scientists for the past two hundred years—of obtaining a soluble nitrogen and restoring the fertility of the soil.

In presenting my subject to this great body, which, in developing illumination, will lift the artistic sense, improve the optics, and add to the physical comfort of the world; a body which is moving hand in hand with civilization, I feel that I am presenting a veritable treasure. It may be that the Illuminating Engineers will find in acetylene an Aladdin's Lamp; and I feel confident that they have but to seize the subject with their keenly intelligent grasp, and the Genii of Progress will arise, and that in their hands new beauties, new utilities and new advances in the illumination of the world will result.

PROCEEDINGS

Papers Read Before Technical Societies

DISCUSSION

Buying and Selling Illumination

By E. Leavenworth Elliott.

Paper read before the Annual Meeting of the Empire State Gas and Electric Association.

Commerce, like science, is based upon measurement. Its growth may therefore be traced through the same stages of evolution. In order to set a money value upon a commodity it is necessary to make two measurements; one of the commodity, and another of the money value. As the adoption of a definite unit of monetary value was the result of a long process of evolution, beginning with the barter of one article for another among the individuals of primitive races, so the measurements of commodities, has, in a similar manner, been developed from what were at first mere rough comparisons. The names of many of the principle units in our present system of weights and measures which we inherited from England, furnish in themselves a history of their origin.

The "yard" was originally the length of the arm, which furnished the most convenient measuring stick. The "foot" was literally the length of the King's foot. The "stone" is a measure of weight still met with in England. The "horsepower" tells its own story. Rough as these units were, their use marked a distinct step in progress from the practice of exchanging one article for another without comparison with any standard.

The progress of civilization has been marked by the continued addition of new commodities. Light, as a commodity, was added to the list when illuminating gas became an article of commerce about a century ago.

The purchase and sale of light has, from the beginning, presented a curious anomaly in commerce; its co-relative money value has never been based upon a measurement of the thing itself, but upon measurements of the commodity from which the light is produced. Thus, in the case of gas light, it is the gas, and not the light, that is measured. This custom has been maintained without deviation to the present time. It developed early in the progress of gas manufacture the amount of light obtainable from a given quantity of gas depends upon the composition of the gas, and also that the gas giving the smaller quantity of light is the cheaper to make. The necessity for a means of measuring the light itself thus arose; and the science of Photometry had its origin in this necessity. Naturally, the early methods of measuring light were crude, and the results correspondingly inaccurate; but crude and inaccurate as they were, they served their purpose of furnishing a means of determining, within certain limits, the illuminating value of the gas supplies. In the course of a hundred years, very considerable progress has been made in the science of photometry, and yet it is to-day far from fulfilling scientific ideals as to accuracy.

But even light itself is not the ultimate thing sought in the use of luminate; it is only a means to an end;—the end is illumination. Illumination is the visual effect produced when light falls upon objects. "Seeing things at night" is the final purpose for which luminants are made, and the plainness and ease with which the objects may be seen is a general measure of the value of the illumination. From the luminant, or means of producing light, to the resulting illumination, there are therefore two steps;—first, the production of light from the luminant, and second, the utilization of the light produced to render objects visible. The importance of distinguishing between these two steps cannot be overestimated. The recognition that light and illumination are two distinct, though co-related things, has given rise

to a new branch of applied science, called "Illuminating Engineering."

Luminants, such as oil, gas and electric current, are commodities which are capable of easy and exact measurement, and their money values may therefore be readily expressed in terms of such measurements, but the purchaser should clearly understand that he is purchasing a luminant, and not light or illumination. The amount of light which he obtains will depend upon the means for using the luminant; and the amount of illumination which he obtains from the light will depend in like manner upon the methods of utilizing the light. In a similar manner coal or other fuel may be purchased for generating power; but the amount of power finally obtained will depend first upon the kind of furnace used to generate heat, and second upon the kind of engine used to convert the heat into mechanical power. The important difference in the comparison lies in the fact that in the latter case there is no possible chance that the puprchaser will have any inconception as to what he is buying; a coal bill is never spoken of as a "power bill." But in the case of the purchase and sale of luminants, there is very generally a vague notion that light or illumination is the actual thing bought and paid for, as is evidenced by the common practice of referring to bills for luminants as "lighting bills." While the purchase of power may be accomplished through the medium of fuel and the necessary devices for its conversion into mechanical energy, no one will deny that its purchase upon a direct measurement of the power itself as a far more satisfactory method. The same principle applies to the purchase and sale of illumination; namely, that in order to set a money value upon illumination, we must have the practical means for its measurement, within reasonable limits of accuracy; and before proceeding with the discussion of such measurement we must again call attention to the distinction between the measurement of light, and the measurement in terms of candle-power, the term when unqualified referring to the intensity of the rays in some direction specified or understood, and when qualified by the phrase "mean spherical," signifying the entire quantity of light produced. Illumination is expressed in foot-candles, the unit being the illumination produced by rays of one candle-power intensity at a distance of one foot from the source. To give this explanation may appear to some to be a reflection upon the intelligence of your members; but the misunderstanding of this distinction is by no means confined to the laity. As an example, a recent article, by a college professor, in one of the leading scientific journals, spoke of "candle-power of illumination."

If further evidence is needed of the general practice of confounding light and illumination, it can be found in any street in which arc lamps are used for producing illumination. It is known that the light-giving power of an arc lamp is large, and it is therefore assumed that it is capable of illuminating a large amount of street surface; whereas the most casual observation will show that such is by no means the case, but that what an arc lamp actually does do, is to illuminate a very small area of the street with a high degree of intensity, or brightness, leaving the remaining portion in comparative darkness. It is easy to conceive of a light-source of great power producing no illumination whatever on the street; for example, imagine search-lights placed so as to throw their beams upward, no matter how thickly placed, the illumination on the street would be practically nil. It is of course true that a large amount of illumination, which may mean either a large surface less brilliantly lighted, or a small surface more brilliantly lighted, requires a correspondingly large quantity of light; but it is by no means true that the production of a large quantity of light results in a large amount of illumination.

To produce illumination the first essential is that the light should reach the objects it is desired to see. This constitutes the problem of proper distribution of the rays. In the second place, the light-source must be so arranged as not to interfere with the eye in the process of seeing. Every one knows that it is impossible to look past a brilliant light and see less brilliant objects beyond it. There is a scientific reason for this, but it is unnecessary to enter into its discussion here; the fact is sufficiently familiar, at least to any one who has ever attempted to distinguish objects beyond an open arc lamp.

To state that the objects of placing light-sources in streets is to facilitate the use of streets by rendering the pavement and the various vehicles and objects within the street visible, is to state a fact that is so self-evident as to appear like a mere waste of words, but it is nevertheless true that lights put up for this ostensible purpose are not paid for on a basis of the extent to which they accomplish this declared pur-

pose, and very frequently their money value is determined entirely independent of any consideration of light whatever.

This practice of paying for one thing, and receiving another, leads to trouble and dissatisfaction on the part of both buyer and seller. The two important steps intervening between the delivery of the luminant and the production of illumination have been entirely neglected. In the case of street lighting, no public officer is charged with looking after these important functions, with the result that the most wasteful, unscientific, and often ludicrous results are obtained. Any method, therefore, by which the final result, *i. e.*, illumination, can be measured and paid for, should be a welcome innovation to both parties to the contract.

The whole question reduces itself to the one simple proposition:—Can illumination be measured with sufficient accuracy, and with sufficiently simple apparatus, to make it a practical basis upon which to base money values? I believe that the present state of the science and art of illuminating engineering justifies an affirmative answer. The technical side of the question has been receiving a great deal of attention during the past year, and a number of new illuminometers have already been brought out, with promise of others to come in the near future. No one will claim that these instruments are capable of giving as accurate results as can be obtained in the measurement of light with a modern photometer in the hands of skilled operators; but it is unquestionably true that illuminometers, even in the hands of the non-professional observer, will give results at least as accurate as were obtained with the photometers used in the early days of commercial gas lighting. Furthermore, the widest errors of the poorest instruments are far less than the actual discrepancies in illumination which are the common result of the illogical practice which now maintains. The only way that illuminometers can be improved is by their practical use. If we are to wait until they are perfected before using them, we may as well dismiss the matter altogether.

Assuming then, that we have an instrument by which illumination can be measured at any given point, and on a plane in any given position, what measurements should be taken as a basis of the payment for illumination? Before answering the main question must be answered.

First, shall the illumination be measured on a horizontal plane, a vertical plane, or a plane normal to the rays in a specified direction?

Illumination on a horizontal plane determines the visibility of the surface of the pavement; illumination on a vertical plane determines, in a general way, the visibility of objects in the street, while illumination on a plane normal to the rays from some particular direction determines the visibility of special objects, such, for example, as a watch face held for reading time, or a card for reading an address.

The illumination on the horizontal is affected by light rays received from every direction, while illumination on the vertical and on the normal plane is affected only by light rays received on one side. Objects in the street are seen only by the light coming from the direction which we are looking; in fact, the less light coming from the opposite direction, the better.

Measurement on the vertical plane offers certain practical advantages; the position of such a plane is easily determined; the measurement may be made without the observer throwing a shadow upon the measuring instrument; in street lighting, the minimum illumination upon a vertical plane is considerably greater than the minimum on a horizontal plane, and as the minimum illumination is frequently so low as to render its measurement difficult at best, it is desirable to avoid the difficulty as far as possible.

The vertical plane, may, in a sense, be considered a compromise between the normal and the horizontal planes. Its adoption as the standard plane for measurement would therefore seem to have the most advantages and the fewest objections.

The position of the test plane with reference to the payment is another important consideration. Theoretically it should be placed on the surface of the pavement; but there are practical objections to this position, the chief of which is the physical inconvenience of making the measurements. The actual difference in illumination between the pavement and a point at a convenient distance, say 30 inches above, is so slight as to be negligible.

Having settled this preliminary question, the main question, as to what measurements should be used as a basis for the payment of street illumination, may now be discussed. With reference to the intensity of illumination, there are four different measurements which are determining factors in the general result:

1. Maximum illumination;
2. Minimum illumination;

3. Average illumination;
4. Illumination at a given distance from the basis of the lamp.

Which one or more of these measurements should be used?

Maximum illumination may be dismissed with little argument. Beyond a certain intensity, which is reached with all ordinary light-sources at the present time, a high maximum illumination is a defect, rather than an advantage, and if any use is made of it therefore, it should be rather to limit it to a certain intensity.

Minimum illumination has many points of advantage. If a certain minimum illumination were specified, motives of economy would induce efforts to reduce the maximum to the lowest possible degree, with a result that a more nearly uniform intensity of illumination would be obtained; and this is the one most desirable improvement to be sought for over the methods that now prevail in street lighting. There are a considerable number of cases, however, in which the minimum is so low as to render its measurement too inexact for practical purposes.

This brings out the fact that street lighting may be divided in two quite distinct classes: First, *street illumination,* in which every part of the street is sufficiently illuminated to make it plainly visible; and second, what may be termed beacon lighting, in which no attempt is made at general illumination of the entire street, but merely to use a sufficient number of light-sources to indicate the direction and location of the street. The name is suggested by the similarity of this kind of lighting to the use of light-houses in harbors and waterways. Beacon lighting forms by no means an inconsiderable part of street lighting. In fact, it is not improbable that the total number of miles of streets lighted in this manner is larger than the mileage of illuminated streets. This cannot generally be set down as a fault. There are a great many cases in which this kind of street lighting serves the purpose sufficiently well, and in which the use of a large enough quantity of light to illuminate the entire length of the street would be unjustifiable expense. If minimum illumination is to be taken as a standard, upon which to base street lighting contracts, it is evident that it can only be applied to those streets which may be classed as "illuminated," leaving beacon lighted streets to be provided for on some other basis.

Average illumination is evidently subject to the same limitations as minimum illumination, *i. e.,* it would be practically unsuitable for beacon lighted streets.

Illumination at a given distance from the base of the light-source offers a way out of the difficulties presented by minimum illumination, and is the method recommended by the Committee of the National Electric Light Association which had the matter under advisement last year. This method amounts practically to the use of the intensity of the light given out by the source at a certain angle. This is theoretically objectionable, as putting a premium on freak illumination, *i. e.,* illumination which has its brilliancy concentrated in one given spot. Practically, however, this objection is of little force, since there are no available means of abnormally concentrating the light at an angle beyond 45 degrees. The actual working of such a standard would therefore be to secure a minimum illumination at the stated distance from the lamps, and a higher degree of illumination between that point and the base of the lamp. The height of the lamp must, of course, in such a case, be specified.

In the case of street illumination, as distinguished from beacon lighting, there seems to be no practical objections to the use of minimum illumination as a basis. This method, carried out in its fullest sense, leaves the whole question of light-sources, height, distance apart and accessories used, wholly within the choice of the seller.

The result of making this the basis of a contract would invariably be the use of light-sources of small candle power, except possibly in the rare cases in which a very high minimum was specified for the purpose of producing spectacular effects. In this case arc lamps would probably hold their own, but in most other cases would be hopelessly outclassed by incandescent electric or gas lamps.

The electric lighting interests have frankly admitted their opposition to such a method of measuring street illumination, for the reason that it would give the advantage to the light; but this is only one side of the story. If better street illumination can be produced at less cost with gas than electricity, the public, *i. e.,* the buyer, will naturally demand gas lighting. What the public wants is the best illumination for the money expended, and is quite unconcerned whether this is produced by gas or electricity, with arcs or incandescents, or what not. It may be stated as a safe phophecy that what the people want

they will in the end have. Ignorance or artificial conditions may for a time restrain the march of progress, but the fittest will always survive and come to the front.

In the case of beacon lighted streets, the only possible method of basing it upon the measurement of illumination, is by the illumination produced at a given distance from the base of the lamp placed at a given height. As previously stated, this amounts practically to specifying a lamp having a certain distribution of its rays, and it would be simpler and more satisfactory to make such a specification at once.

The payment for street illumination on the basis of the illumination produced offers advantages to both buyer and seller. The buyer pays for the actual goods delivered, it puts a premium upon progress and improvement, of which the producer will reap the first advantage. Thus, if a more efficient form of lamp is developed, by which the stated illumination can be produced as less cost, it is obvious that the producer will be the gainer, at least for a greater or less length of time.

A reform, therefore, which works to the advantage of all parties, and to the disadvantage of none, is worthy of at least a most careful and serious consideration. That there is ample need of reform in the general practice of street lighting, both professional and laymen must agree; and there is no surer means of inaugurating such a reform than to make better practices profitable to all concerned.

Factory Lighting

By J. T. Kermode.

Paper read at the Toledo convention of the Ohio Electric Light Association on August 20th.

The fact that many manufacturing concerns are vacating their old premises to enter buildings of more modern construction, with saw-tooth roofs, and windows on practically four sides, is evidence that better lighted workrooms are essential and that the demand for a higher standard of artificial illumination is rapidly increasing. The short hours' use and usually heavy demand on the station peak has brought about a condition where there is some question as to the advisability of factory lighting from a supply company's standpoint; it is, however, very important when combined with the supply of power. In conjunction with power business, considerable work has been done in Cleveland, where it has been the policy to make surveys, plans, specifications and to obtain bids for this class of wiring with special reference to the best and most economical method of illumination for the various kinds of work in different processes of manufacture.

The average factory requires artificial light during 10 to 20 per cent. of the working hours, not including overtime or night shifts; therefore, the illumination should be sufficient and the lamps so arranged that the quality and quantity of work accomplished during these hours can be as well and economically done as that which is performed by daylight. The amount of light required varies, first, with the size of room, relative position of machines and the general shop conditions, and, second, with the character of work to be done. The treatment that will effectively light a clothing factory cannot be efficiently applied to industrial plants, where the atmosphere is filled with smoke and dust.

Experience has taught us that no general rule can be laid down to govern the many different situations that present themselves, but each factory must be studied separately to determine the amount of light, style of illuminant and the method of its installation, to give the best results. For instance, large units cannot be successfully operated in roundhouses or car shops. The principal parts of locomotives that need special attention are so located that to be of value the source of light must be reflected from each side of the engine. Five 100-watt Gem lamps, spaced 15 feet apart, at an elevation of seven feet, will light in a very satisfactory manner one side of two engines. Oil torches, so commonly used in cabs, boiler and floor pits, can be conveniently substituted with portable incandescent lamps.

In foundries, forges, steel mills, structural-iron works and boiler shops, where the walls are dark and the work does not require concentrated light, a lamp is needed that will give good general illumination. Enclosed arc lamps, giving a white light, combined with shadows, are undesirable for this class of work, as the dark walls and dense atmosphere absorb a large percentage of their penetrating powers.

The color and brilliancy of light produced by the flaming arc has attracted the attention of many manufacturing concerns, and, notwithstanding the cost of lamps and carbons, they are being extensively used to light large areas.

In a large mill operating steel presses 16 enclosed arcs were installed. On account

of the dense atmosphere these lamps were hung below the tops of the presses, resulting in heavy shadows being cast around each machine. The 16 enclosed arcs were recently substituted by six flaming arcs. With slight changes in the wiring these arcs were placed 22 feet from the floor, resulting in the entire shop being flooded with a warm, bright light. The use of flaming arcs reduced the connected load 4.5 kilowatts. Averaging two hours' use a day, these lamps would save 234 kilowatt-hours per month, which, at the usual prevailing lighting rate for current, would more than compensate for the cost of carbons, without considering the increased amount of illumination.

It is generally conceded that the best uniform illumination can be obtained by distributing small units over the space to be lighted, but this is not always practical, for one must consider the building construction, and purpose for which the space is to be used.

The use of higher candle power arc lamps for factory lighting is rapidly increasing, and the advantage that can be obtained by their use and efficiency must be recognized. The efficiency with which the light is produced and utilized are two important factors with which a supply company is intimately concerned.

In machine shops it is common practice, together with large units for general illumination, to furnish each workman with a single incandescent lamp, which when new, and at average height from his work, usually gives a fair amount of light. Oil and dust soon reduces the illumination one-half.

But it is not expected that the amount of work shrould reduce in the same proportion. Some reasons why this practice has become so popular are:

First—That up to a few years ago the majority of industrial shops were equipped with generating apparatus, but the cost of electric lighting was charged against the operation of the shop and not against the cost of electricity as it should have been. Invariably I have found that where light is obtained in this manner the generators, feeders and branch circuits are heavily loaded with inefficient apparatus and there is no incentive to economize on current.

Second—Wherever a large installation is necessary the manufacturer usually employs a man to look after the operation, repairs and additions to the electrical equipment. These men, as a rule, are not familiar with the improvements that are continually being made on the various devices that go to make up a modern electric installation. Consequently inefficient light facilities are unintelligently installed.

Third—Employes have been educated to believe their work cannot be successfully performed unless each individual is furnished with an incandescent lamp, and realizing the flexibility of electricity it seems comparatively easy for one to convince the foreman that an additional lamp should be added here or there, resulting in an overlamped room for the number of machines operated and a poorly lighted room at an excessive cost.

In machine shops where lathes, drill presses, planing machines, milling machines, screw machines, punches, etc., are used good general illumination of uniform intensity is required. Nernst or Gem lamps are well adapted for this class of lighting.

The size and number of lamps to be used depends upon the size of the room, height of ceiling, color of walls, location of machines, belts and shafting. In estimating the size and number of units it might be of service to consider 50 watts per operator, or machine, as an average amount for all ordinary machine work and general illumination. For special machines or work that needs bright light, individual incandescent lamps with reflectors should be used. Machines that are automatic in their operation are many times provided with unnecessary individual lamps. Appreciating that these machines do need good light for changing their adjustment, the use of portable lamps that can be connected to receptacles near each machine will, if intelligently used, save current.

The general evenness of illumination, with the absence of glare, together with the easy shadows and searching quality of the light produced by mercury-vapor lamps, makes them especially adaptable for factory lighting by direct current. Unfortunately the alternating-current lamp up to the present time has not been successful, due to its inability to start readily.

Manufacturers of clothing require an even, shadowless, well-diffused light of considerable brilliancy. Nernst lamps with prismatic reflectors can be utilized for this purpose with a comparatively low consumption per operator.

The difficulties that exist in factory lighting are familiar to all men engaged in the sale of electricity for power purposes, and it should be the duty of each central station to educate its men to successfully overcome these conditions by encouraging the use of

lamps, shades and reflectors that have been produced for scientifically converting wasted energy into useful light. Recent discoveries in the production of electric lighting are of revolutionary nature, the same principles which have been utilized in the cheapening of gas light, that is, the use of the peculiar properties of rare earths and metals, have been appropriated by the electrical interest, and the recent developments indicate that the efficiency of the electric lamp will be doubled in the near future.

Recently I read an article in which a supply company recommends the use of gas for factory lighting that they might be successful in retaining power business.

Is there a more exaggerated case of false economy than that of requiring people to work by poor illumination? In comparison with the cost of labor the cost of lighting is trifling. Take, as an illustration, the case of a skilled workman receiving $3 or $4 a day (say an average of 30 cents an hour, or one-half cent a minute), figure the cost of a 16-candle power lamp burning 10 hours, and see how many minutes of the man's time it requires to pay for the light. Yet there are thousands of skilled mechanics handicapped with insufficient and ill-directed light.

Relative Cost of Light from Different Sources

By C. Henry Irwin.

Read at the First Meeting of the Representatives of the Suburban Gas Co., Chester, Pa.

A. FLAT FLAME OIL LAMP.

Lamps of this type will consume about .94 gallons of kerosene in one month of ninety hours, averaging about 10.2 candle-power, so that the cost per month with oil at fourteen cents per gallon will be 13.2 cents. Assuming that the lamp requires one wick every six (6) months and two chimneys every month, the cost will be increased to 29.5 cents or 2.9 cents per candle-power per month.

B. ROCHESTER LAMP.

Lamps of this type will consume about three gallons of kerosene in one month of ninety hours, averaging about 33.2 candle-power, so that the cost per month at ourteen cents per gallon of oil will be forty-two cents. Assuming that the lamp requires one wick every six months and two chimneys every month, the cost will be increased to 62.5 cents, or 1.89 cents per candle-power per month.

C. HIGH PRESSURE KEROSENE LAMPS WITH MANTLES.

Lamps of this type (Kitson, etc.) will consume about 3.4 gallons of kerosene per mantle in one month of ninety hours, averaging about 112 candle-power per mantle, so that the cost per month with oil at fourteen cents per gallon will be 47.6 cents. Assuming that one globe every four months and one mantle per month is required, the cost will be increased to 91.6 cents, or .87 cent per candle-power per month.

The lamp is, however, unsatisfactory for indoor use, as it always makes more or less noise and gives off an odor, while it frequently drips oil. It also requires a good deal of attention, and the average man cannot keep it in proper working order.

D. OPEN FLAME GASOLINE LIGHTS.

We have been unable to secure data in regard to this form of light, as there are no machines in use here now.

E. GASOLINE LAMPS WITH MANTLE.

Lamps of this type, feeding gasoline with a gravity pressure of about 12 inches of water, will consume about two gallons of oil per mantle per month of ninety hours averaging thirty candle-power, so that the cost per month with gasoline at eighteen cents per gallon will be about thirty-six cents. Assuming that a chimney and mantle is required every three months, the cost will be increased to fifty cents per month, or 1.67 cents per candle-power per month.

F. HIGHER PRESSURE GASOLINE LIGHTS WITH MANTLES, SUCH AS THE S. K. LIGHTS.

We have been unable to secure data in regard to these, as there are none in use here. They should, however, give somewhere near the same results as the high pressure oil lights (Kitson, etc.).

They are, however, much more dangerous, being the frequent source of fires.

G. OPEN BURNERS GAS FLAME.

Such a flame, burning at the rate of 5 feet per hour for one month, of ninety hours and producing twenty candle-power, will cost, with gas at $1 per 1,000, forty-five cents, or 2.2 per candle-power per month.

H. WELSBACH BURNER.

Such a burner, burning at the rate of 3.5 cubic feet per hour, and developing six candle-power, will cost 33.5 cents per month of ninety hours. Assuming that one chimney is used every three month and one mantle is used every six weeks, the cost will be increased to 56.5 cents per month or .94 cents per candle-power per month.

HIGH PRESSURE GAS LAMPS.

Lamps of this type (Scott, Snell, etc.) will develop forty-two candles per cubic foot of gas, and assuming that 5 cubic feet of gas is used, it will cost forty-five cents per month of ninety hours to develop 210 candle-power. Assuming that one globe every four months and one mantle every month is required the cost will be increased to ninety-five cents or forty-five cents per candle-power per month.

J. INCANDESCENT ELECTRIC LIGHTS.

A 16-candle-power incandescent electric light of 3.1 watts per candle efficiency and requiring 55 watts per hour will produce 17.7 candle-power. Such a lamp will use 4,950 watts per month of ninety hours, and at ten cents per kw. will cost 9.5 cents or 2.8 cents per candle-power per month.

K. NERNST LAMPS.

A three glower Nernst lamp using 88 watts per glower or 264 watts per hour, with an efficiency of 1.6 watts per candle-power, will produce 165 candle-power, and will consume 23,760 watts per month of ninety hours. The cost will be for current $2.37 per month. Assuming that the cost for maintenance for this period is fourteen cents (six cents per kw. hr.), the cost per candle-power per month will be 1.52 cents.

L. ELECTRIC ARC LAMPS.

Assuming that an arc lamp uses 459 watts and produces an average of 200 candle-power, the cost per ninety hour month with current at ten cents per kw. will be 4.05 or 1.35 cents per candle-power per month.

From the above figures it is apparent that gas can compete successfully with kerosene or gasoline in respect to actual cost per candle-power, while it is much more convenient and less dangerous.

Electricity can hardly compete with oil or kerosene in price, except when current is sold at a very low rate, but the convenience and safety which result from its use place it in a class by itself. It fills a want no other form of illuminations can satisfy.

Incandescent Illuminants

By James Swinburne.

Paper read before the Royal Institution.

There has been much discussion about the theory of the incandescent mantle. It has been generally assumed that the temperature of a Bunsen burner is too low for a mantle to give the light it does by simple radiation, unless it is much hotter than the flame. Unfortunately, the temperature of the flame is generally taken with a thermo-couple; and this gives far too low a reading, as the thermo-couple never reaches the real temperature of the flame. But admitting that the temperature of the flame is high, it is still urged that the light given by the thoria with a small percentage of ceria is so great that there is something else than mere thermal radiation. It is said that the ceria acts as a catalytic agent, and that it oscillates between two states of oxidation. Ceria does act somewhat in the same way as platinum. For instance, if a ceria mantle is put on a lighted burner, and the burner turned out, and the gas then turned on again, the ceria mantle will glow, and will finally light the gas. It is odd that this is not brought forward by the advocates of the catalysis theory; but the opponents might urge that zirconia will do the same thing, and the zirconia mantle gives very little light.

According to the simple radiation theory, the light depends only on the emissivity, or blackness, of the mantle, and its temperature. Its temperature must be lower than the flame, as it must be robbing the flame of the heat it radiates. In order to give the flame every chance of supplying the heat, the threads of the mantle have to be made very fine, so that the flame can rush through the meshes; and the hot gas should be in brisk movement through the interstices of the mantle. By using a special draught arrangement (known as the intensive system), about twice the light per cubic foot of gas can be obtained. In order to get the highest temperature, the emissivity should be low —that is to say, the mantle should be very white; but then, though it would get to a high temperature, it would give very little light. On increasing the emissivity, the light will first increase; but this means a

lower temperature, so that as the emissivity is increased from white to black, the total radiation increases. As, however, this means a greater abstraction of heat from the flame, the mantle is cooler, and therefore radiates a larger proportion of the energy as heat, and a smaller proportion as light; so the mantle gets redder and gives less light. This is just what happens in practice, whether ceria or any other colored oxide is used.

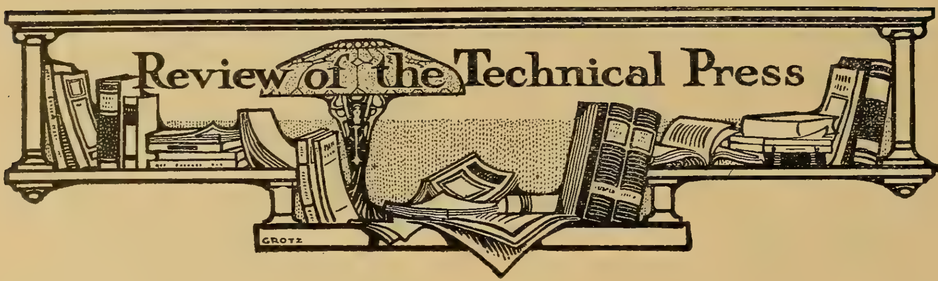
It has been urged that, as pure ceria is white, adding it cannot make the mantle blacker. But ceria is white only when cold. A mantle may look quite white cold, and be darker in color when hot. Rubens has devised an experiment to show this. The mantle is strongly illuminated by an arc and condenser, and its image is thrown on the ground. It looks quite white, of course. On lighting the gas, the mantle, instead of becoming still brighter, at once becomes dull. Again, alumina, which is white, gives little light; and chromium oxide is so dark that it gives only a dull red glow. On adding a little chromium oxide to the alumina, however, a dark red light is first given, because the chromium oxide is too dark; but as soon as it combines with the alumina to make a light pink mantle, a good light is obtained.

One of the drawbacks to gas, compared with electric lighting, is that merely turning on does not light gas. This difficulty has been largely overcome by the use of the bye-pass; but further advances have been made. Welsbach has discovered that an alloy of cerium and iron gives off sparks on being scraped or filed; and a burner has been designed in which the act of turning on the gas scrapes a little wheel of this alloy, causing a spark which lights the gas. This overcomes the drawback of having a little jet always burning. Another invention allows the gas to be lighted from a main-tap. Each burner has an attachment, which lets the gas straight through to the burner when the pressure is on; but on turning the main supply off, and allowing a little gas to pass at the controlling tap, the attachment to each little pilot-jet, which keeps burning until light is wanted again. On turning on the main-tap, the pilot-jets light the various burners, and go out themselves. By this means, burners can be fully lighted up by turning one tap at the door of the room.

The electric incandescent light is undergoing a great change. Carbon is being replaced by metal wires. It has been found possible to make wires of high enough resistances of tungsten, osmium, tantalum, and a few other metals and compounds. The osmium lamp was the first of these; but there was difficulty in making it of high enough resistances. The tantalum lamp is now in great demand. It is made for 100 to 130 volts, and is much more efficient than the carbon lamp. It will not, burner turns off the burner and lights a however, last long on alternating currents. The wires of a lamp that have been run for some time on a direct current show a curious notched or crinkled appearance under the microscope. But a wire that has been run on an alternating circuit looks as if the metal had been melted into short cylinders with round ends, and these cylinders had stuck together end to end without their centers being in a line. Sometimes the little cylinders are nearly separated, merely touching at a corner. This action is very extraordinary, and has never been explianed. In addition to this, when a lamp breaks down on an alternating circuit, the wire sometimes goes at one point and sometimes it breaks in several places, and tangles itself up in an extraordinary way; while at other times it breaks up into numerous little pieces, which will be found lying on the inside of the globe. Some of the other lamps show a change under the action of the current; but it is not so marked as in the case of tantalum.

One of the most interesting of the new lamps is the zircon. It is said to be formed of zirconium and tungsten; and lamps of this material have been made for 200 volts —a matter of the greatest importance from a distribution point of view. It is possible that the conductor is really a zirconide of tungsten; and this opens up a new series of compounds. A zircon lamp for 100 volts has really six separate loops of wire mounted in series inside a bulb. A recent improvement is to provide an extremely light spring for each loop, so as to keep it taut. The lamp can then be used in any position.

Tungsten appears to be the favorite metal, as it gives a very high efficiency. It is probable the lamp of the future will have an efficiency of nearly a candle per watt; and this is promised by the use of tungsten. At the same time, it must be admitted that to make a wire with a resistance of 500 ohms small enough to give 20 candles with 20 watts, is a triumph of inventive skill.



American Items

CONTRIBUTED ARTICLES.

ILLUMINATION OF THE NEW UNION STATION AT WASHINGTON, D. C., *Railway Engineering Review*. Gives the general features of the lighting installation of this new $20,000,000 terminal. The lighting units will consist of 480 500-watt arc lamps; 500 high-efficiency lamps, and about 3,600 16-c.p. incandescent lamps.

FLAMING ARC LAMPS ABROAD; *Electrical Review*. Gives brief, but very interesting data as to the use of this new form arc light in the principal countries of the world, with characteristic illustrations showing the lamps installed in Australia, New Zealand, India, China and Japan.

ELECTRIC SIGNS IN SEATTLE; H. Cole Estep, *Electrical World*. The article describes successful methods used by the Seattle Electric Company in securing this line of business.

ELECTRICAL DECORATIONS AT SAN JOSE, CAL., by E. E. Pomeroy, *Electrical World*. Gives three illustrations of the special electrical decoration during the recent "Native Sons'" celebration.

HELION LAMP, by W. G. Clarke and H. C. Parker, *School of Mines* (Columbia University) *Quarterly*. A description of their new filament, details of which have already been generally known.

HIGH EFFICIENCY LAMPS AND CENTRAL STATION REVENUE, by H. S. Knowlton; *Electrical World*. The writer starts out with the assurance that "looking at the matter in a broad way, it is difficult to see any real grounds for apprehension, and concludes that their introduction will increase the general use of electricity for other purposes than lighting.

EDITORIALS.

ELECTRICAL WORLD.

The New Luminants and Gas Competition. The conclusion reached from a review of the situation is as follows:

> At a casual overlook of the situation it appears then that in street lighting lies the most successful line of attack on the present field of competition with gas, with the new lamps as weapons. Small shops also afford a good chance, but residential work requires a radical change in the usual rates policy in order to secure the business. From a strategic standpoint, however, residence lighting, as we have frequently pointed out, is of no small importance and deserves to be cultivated.

Color Photometry; reviews the principle obstacles in the way of color photometry, and especially refers to the use of the Lummer-Brodhun screen for this purpose.

Standards of Light; A review suggested by the recent meeting of the International Photometric Commission in Zurich, and the paper by Dr. Hyde of the "Bureau of Standards" on this subject.

Incandescent Lamp Specifications; A discussion of the recent requirements of the U. S. Government.

Illuminating Engineering as a Business-Getter. The trend of the article is illustrated in the statement that "as time goes on, the successful central station solicitor and commercial man must acquire a good knowledge of illuminating engineering, and put it in practice, if he is to be of the most use to himself and his company."

ELECTRICAL REVIEW.

Illumination as an Art. A review of an article on the same subject by Bassett Jones, Jr., in the preceding issue of the *Review.*

Reprints

The Sacrifice of the Eyes of School Children

BY PROFESSOR WALTER D. SCOTT,

NORTHWESTERN UNIVERSITY.

From Popular Science Monthly.

In the evolution of the animal organism the sense of touch has served the purpose of informing the individual of objects with which it came in contact. The sense of taste likewise gave information concerning objects upon contact, but of a more specialized form. The sense of smell and that of hearing gave knowledge of objects in the vicinity and in certain instances of objects in the distance. The sense of sight seems to have been preeminently the sense by means of which the individual was enabled to adjust himself to objects at a distance. The enemy to the leeward might approach noiselessly and so could not be smelt or heard. When knowledge of approach was revealed by the sense of touch it was too late for escape. The preservation of the individual and of the species thus depended upon the ability to see the enemy in the distance. Inasmuch as the function of the eyes has been to perceive objects at a distance rather than at close range, we are not at all surprised to find that the eyes are well adapted for distant vision, but poorly constructed for close work.

When our eyes are at perfect rest, when all the muscles which control them are relaxed, they are then adjusted for distant vision. When, on the other hand, the ciliary muscles and the muscles which move the eyeballs are at a maximum of contraction, then and then only are the eyes adjusted for close vision. Such a structure was admirably adapted to the needs of the primitive organism. The eyes were the sentinels which must always be on guard and when employed in the appropriate way there was no strain. It was of course essential that the individual should be able at times to see objects close at hand. This could be accomplished by means of contractions of delicate muscles, and as soon as the contractions were relieved the eyes were again adjusted for the more important duty of distant vision.

The strain upon the eyes is in adjusting for objects closer than at about four feet, but for all greater distances there is a minimum of strain. Hence we may speak of all objects as being *distant* which are removed as much as four feet. With this definition of the term distant it is evident that distant vision was the most common form of vision for all our ancestors, from the most primitive forms of life to the most highly civilized races, till the last few centuries. With the invention of writing and then with the invention of the printing-press a new element was introduced, and one evidently not provided for by the process of evolution. The human eye which had been evolved for distant vision is being forced to perform a new part, one for which it had not been evolved, and for which it is poorly adapted. The difficulty is being daily augmented. The invention of printing presses has been followed by an increasing number of books, magazines and daily papers. The rural population has given place to the urban. The long days of manual labor have given way to the eight-hour system with abundant time for reading. Labor-saving devices of all sorts have added to our sedentary habits. All things seem to be conspiring to make us use our eyes more and more for the very thing for which they are the most poorly adapted. It requires no prophet to foresee that such a perversion in the use of an organ will surely result in a great sacrifice of energy, if not of health and of general efficiency.

THE AMOUNT OF LIGHT REQUIRED FOR READING.

The eye has thus far been spoken of as though it consisted merely of delicate muscles, when in reality these are not the most

significant part of it. In thinking of the eye we should never disregard the eye-muscles, but primarily the eye is a live camera consisting of a lens, dark box and sensitive plate. The retina in the back part of the eyeball is the sensitive plate and is the most vital part of the eye. It is effected by every ray of light falling upon it. Fortunately it responds to a weak light and still is not injured by a moderately strong one. In speaking of the quantity of light it is well to have a standard. For this purpose the most convenient standard is the amount of light cast by a standard candle upon any point in the horizontal direction one foot from the candle. A light of twice this intensity is spoken of as a two-candle power, a light ten times the first is of course a ten-candle power. The light cast by a candle upon a printed page at a distance of one foot is sufficient for legibility at the normal reading distance. If the light is less than this the retina is not adequately stimulated and the reading is accomplished only after a strain more or less intense. If the light falling upon the page exceeds ten-candle power the stimulation of the retina is so great that it is displeasing to some people and is condemned by our best authorities as injurious to the retina. All are agreed that less than a single candle-power is injurious for reading, and during the present state of our knowledge it is at least safe to avoid an illumination of more than ten-candle power.

The iris may be blue, brown or gray and is that which determines the color of our eyes. It is an adjustable shutter which reflexly regulates the amount of light which enters the eye. In the presence of a bright light the iris diaphragm contracts, reducing the size of the pupil and cutting out much of the light which would otherwise enter the eye. In the presence of a dull light the pupil enlarges, allowing a great amount of the light, such as that falling upon a book, to enter the eye and to stimulate the retina. The iris is a wonderful device, but can not in diverse illuminations perfectly equalize the amount of light entering the eye. The pupil expands inversely as the square root of the illumination. Thus if the actual illumination of the book increases ten-fold, the amount of light falling upon the retina is increased but little over three-fold. Even a twenty-five candle light sends but five-fold as much light into the eye as a single candle-power. A single candle-power seems sufficient and ten-candle power is not too much. This ability of the retina and of the iris to deal successfully with lights of such different intensities is a most useful and necessary characteristic. Unfortunately, however, the actual diversities of intensities of lights used for reading are far beyond any for which the eye can adapt itself.

VARIATIONS IN THE AMOUNT OF DAYLIGHT.

We are in the habit of thinking of the light received from the sky—the daylight—as almost a fixed quantity during the hours from 9 in the morning till about 4 in the afternoon. The darkness preceding a storm and the occasional dark days are of course not forgotten, but, in general, daylight for the hours mentioned is thought of as at least fairly constant. To test this point observations were made at 9 A. M., 12:30 P. M., and 4:30 P. M., daily for five and one-half days a week for 22 months. These tests were made in the Chicago laboratory of the American Luxfer Prism Co., and under direction of Professor Olin H. Basquin, of the Department of Physics of Northwestern University. Inasmuch as the amount of sunshine and general illumination in Chicago is almost exactly the average for the United States, these results may be regarded as typical for the whole country with the exception of such dark cities as Seattle or such light ones as Phœnix. Measurements were made of the amount of light coming through a square foot of clear glass placed horizontally in the roof of the observation building. The illuminometer was placed so far below the opening in the ceiling that the direct rays of the sun could never reach any part of the recording apparatus. The light thus measured was diffuse daylight received from the zenith of the sky. Taking the average illumination for the 22 months at 12:30 as the standard, it was found that the illumination at 9 A. M. was but 67 per cent. as great as that of mid-day. Again the illumination at 4:30 P. M. was but 27 per cent. as great as that at 12:30. Expressed in other terms, we see that the available light at 4:30 is approximately but one-fourth that of noon and the light at 9 o'clock but two-thirds that of noon. These figures are the average for the school days of 22 months in one city, and although observations for a longer period and in other cities might change the results somewhat, it is safe to assume that our figures are not far from the actual conditions in a majority of our school rooms in the United States. In general a room which is barely adequately lighted at 12:30 will be 33 per cent. under-illumuinated at 9 o'clock, and at 4 o'clock

its illumination will be but 27 per cent. of the necessary amount.

Our difficulties are further complicated by the fact that the variations in illumination of daylight are as great between the months of the school year as between the hours of the school day. The illumination is best in the months of June, July, August and September. Then follows in order May, April, March, October, February, November, January and lastly December. Comparing the illumination of the four bright months (June, July, August and September) with the four dark months (November, December, January and February) we find that for the 22 months observed the illumination of the dark months is but 28 per cent. of that of the bright ones. This figure is found by averaging the three daily readings for each day for all the months concerned. December, the darkest month, has but 18 per cent. as great illumination as June, the brightest month.

When to these variations as between months or seasons we add the variations between mid-day and morning and evening, the results are most astounding. The light at noonday in June averages almost tenfold as much as that at 9 A. M. in December. If it is injurious to read with a light less than one or more than ten-candle power, a schoolroom that furnishes this maximum in June will be reduced to the minimum in December mornings and evenings on average days. Such deviations in the external source of light put most restricting conditions upon school architecture. How have we met the conditions and how might we construct our schoolrooms to meet the situation satisfactorily?

RULES FOR LIGHTING A SCHOOLROOM.

In our climate it is almost impossible to over-light a school room if the two following conditions are observed: (1) Never allow the direct rays of the sun to fall upon any surface within the field of vision of any pupil. (2) Avoid all glossy or shiny surfaces which reflect the light directly into the eyes of the pupils. A dead white surface is not injurious, while a darker surface may be shiny and hence injurious.

For securing adequate light the following rules are important: (1) The window space should be as much as one-fifth of the total floor space, and the height of the window two-thirds of the width of the room. (2) The walls, ceiling, woodwork, furniture, etc., should be a color which reflects a large amount of well-diffused light. Perhaps the best colors for this purpose, in the order of their efficiency, are white, light yellow, light gray, light green, light blue and light pink. (3) The schoolroom should be narrow and the windows facing an unobstructed area, so that from any seat in the room a large amount of sky is visible. (4) The windows should be provided with white Holland screens, or others of a similar sort, which obstruct the direct rays of the sun, but which, when drawn down, emit into the room a maximum of diffused light. (5) There should be at hand light colored curtains which may be used to cover up all blackboards as soon as the darker parts of the room are inadequately lighted.

It is apparent to all that the construction of our school rooms has not conformed to these five simple rules. There are many rooms in which the window space is one-fifth of the floor space, but certainly not a majority of all school rooms in America. The second rule, concerning the reflecting surfaces within the school room, is broken by the extensive surfaces of black-boards and by the dingy color of the walls. Walls soon fade and become dirty and need frequent attention to keep their reflecting power approximately at its maximum. The third rule is broken by constructing rooms so large that they will accommodate fifty pupils, and by placing school buildings too close to adjoining buildings. The fourth rule is broken by the use of opaque shades which, when drawn to escape the brilliancy of the sun, leave the room darker than it would otherwise be on a dark and cloudy day. Because of this fact the schoolrooms with a southern exposure are perhaps our most poorly lighted rooms. The fifth rule, concerning the use of white screens for the black-boards, is never observed and to many may seem insignificant. The justification of the rule is found in the following facts.

DARK CORNERS IN SCHOOLROOMS.

The ordinary school room has the light from one side. The five rows of desks are so arranged that one row is next to the windows and the last row next to the blackboard on the side of the room opposite the windows. It is well known that the desks next to the black-board and farthest from the windows receive less light than the desks next the windows. That the difference between the first and fifth rows is great enough to occasion any alarm seems not to have been suspected. In the ordinary school room the light reflected from the pupil's book on the first row is eight times as great as the light reflected from the book of the pupil who is so unfortunate

as to sit in the row next to the blackboard. The decrease of the light as the distance from the window increases is different in each room. The law of the square of the distance is not even approximately correct but it is safe to say that in the great majority of school rooms in the United States the row of desks next to the windows has many-fold more light than the rows next the black-boards. Professor Basquin and I tested school rooms having windows on but one side. In these rooms the variation between the first and fifth rows was from seven-fold to ten-fold. By the introduction of screens over the blackboards in the same rooms, the light at the darkest seat was increased as much as 50 per cent. That an increase of 50 per cent. in the light in the dark corners of our school rooms is important is apparent to all. Furthermore, this result can be secured with little or no cost. Most schools possess white screens, light-colored advertising maps, charts printed on white paper, etc. They may be used to cover the blackboards and when thus used they will reflect the light to the very parts of the rooms which need it most.

Because of the lack of attention which is paid to the light actually present in the school room, and because of the great difficulty in adjusting our windows and shades to the varying intensities of the external source of light, it is not surprising that we should find in our school rooms conditions of light so bad that during many hours and days the reading of ordinary printed matter without undue strain upon the eyes is impossible.

UNWISE DEMANDS MADE UPON THE EYES OF YOUNG CHILDREN.

Until within a very few decades reading was taught by a slow and cumbrous method. The effort of reading was so great that few children enjoyed the reading of a book until after they had completed the third school year. Interesting books for children were few in number and not available for the vast majority of them. To-day this is all changed. Our methods of teaching reading are so improved that before the child has been in school a full year he begins to read books at home for his own pleasure. Our printing presses are teeming with children's books. Andrew Carnegie, or rather the movement which he so ably supports, has filled city and country with free books available for even the youngest. During the last twelve months I have tested the eyes of some 700 children. I have asked of each child an estimate of the number of books read in the preceding 12 months. One room of 31 pupils for the 12 months preceding the middle of the second school year, gave the following figures. The average number of books read by each pupil was 22. Some had read but few, while others had read many more than 22. One-half of the pupils had read 20 books or more. It should be observed that this record of the number of books covers the period from the middle of the first school year to the middle of the second school year. After the second school year many pupils read regularly a book a week. In several of the grade rooms tested, the pupils of the room read on the average as many as 50 books a year. In the first three years after reaching the legal school age not a few pupils in our best city schools read 100 books. This figure is certainly far above the average, but there is a tendency to increase the number of books read during these first three years of school. We should but deprecate the tendency and do all we can to stop it. During these three years the pupils are growing faster than during the following years. At this time there is a decrease in the nervous energy of the child. In recent studies of the order of development of motor adjustments and coordinations, it has been found that the individual first acquires control over the larger muscles and later over the finer ones. The normal activity of the child exercises mainly the larger muscles. The plays of children give the widest scope to the exercises of such muscles. The coarser movements are most predominant while the finer adjustments and the use of the smaller muscles are of secondary importance.

By our improved forms of modern education all this is changed. We put the six-year-old child to the task of reading and writing. These acts involve the use of the smaller muscles of the organism and are dependent upon more exact control of these muscles than any other act the individual is ever likely to be called upon to execute in later life. If an adult is out of practise in the use of the pen, a single hour's work is sufficient to exhaust the hand. The extreme exertion which the child puts forth to guide the pen or to follow line upon line with the eyes is so far in excess of the amount of energy required by an adult that we are not in a position to appreciate the severity of the child's task. Children upon entering school have better control of movements involving the

whole arm and the wrist than of those involving the wrist and fingers. The muscular control of the eyes is adequate for all free movements of the eyes, but not sufficient to warrant the finer adjustments of continuous reading. The loss of nervous energy, necessitated by reading and writing, at the ages of from five to eight years is an unwarranted drain upon the health of the child. At this age the child needs free and vigorous movements rather than the constrained and finer ones required in reading and writing. At a later age the control over the finer muscles is adequate for the task, but in this age of rush we are crowding our little ones and inverting the order of nature. Furthermore, the tissues of the globes of the eyes are still soft and the strain of the ciliary and other eye muscles is likely to cause short-sightedness by increasing the anterior-posterior axis of the eyeballs. If the child's eyes do thus lengthen under the excessive strain, the eyes are not only weakened for vision, but they become diseased organs.

We have thus far attempted to establish the following four propositions. (1) The human eye was evolved for distant vision and the perversion incident to reading and writing would lead us to expect some great injury to the organism. (2) Although the eye may easily adjust itself to a light changing from one- to ten-candle power, the diversities of daylight during the hours of the school day and the months of the school year are so great that the minimum and maximum extremes are frequently exceeded. (3) The necessary rules for lighting buildings are not adhered to, thus placing an unnecessary strain upon the eyes of all attempting to read and write. (4) There is a growing tendency to use the eyes at a period of life which is in every way ill fitted to the task. If these four propositions have been established, and if the pessimistic forebodings are justified, then investigations of the eyes should discover a general destruction of the eyes of civilized countries and an increasing number of eyes injured during the age of from 6 to 9.

INVESTIGATING THE EYES OF SCHOOL CHILDREN.

Systematic investigations of eyes upon a wide scale were not begun till 1865. At that date Dr. Herman Cohn commenced his investigations of the eyes of school children in Breslau. After having examinted ten thousand children, he summarized his results as follows:

Short-sightedness hardly exists in the village schools; the number of cases increases steadily with the increasing demands which the schools make upon the eyes, and reaches the highest point in the gymnasia.

The number of short-sighted scholars rises regularly from the lowest to the highest classes in all institutions.

The average degree of myopia increases from class to class, that is, the short-sighted become more so.

The circular of information of the United States Bureau of Information, No. 6, 1881, in speaking of the many investigations which had been made in this and other countries said:

All without a single exception, prove beyond a doubt that near-sightedness, beginning, perhaps, at nothing in the lower classes in the school and first year of school life, steadily increases from class to class in the school until in the highest grades or in the last years of school attendance it has actually developed itself in as many as 60 or 70 per cent. of all the pupils.

In all these tests children were not regarded as near-sighted unless their visual acuity in one or both eyes was but two-thirds of normal vision or less. Think of the significance of these statements which are entirely authoritative. Pupils entering our schools come to us with good eyes, but if they stay with us till the end of the course, 60 to 70 per cent. of them will leave us with but two-thirds normal visual acuity or less. Most of this loss of vision is caused directly by the strain put upon the eyes in reading, writing and drawing.

THE SACRIFICES CAUSED BY PREMATURE STRAIN.

The picture drawn by the investigators during the two decades following 1865 was dark indeed. The only ray of hope was found in the fact that the destruction of the eyes did not begin during the first few years of school, so that pupils dropping out before the eighth or tenth year would probably escape with good eyes. Thus Cohn found that in the case of pupils 8½ years old there were but 5 per cent. myopic, while of the pupils remaining the full 14 years, 63.6 per cent. were myopic. Investigations of the pupils of other cities of Germany resulted in similar findings. Investigations in America were not so numerous as those in Germany, but in general the results were the same until recent years.

Investigations carried on in Worcester, Massachusetts, in 1891, showed that in the second and third grades from 50 to 60 per

cent. of the pupils possessed less than normal visual acuity. Investigations upon over 3,700 pupils of the Chicago public schools, in 1899, showed that the maximum of defective eyes was reached with pupils 9 years old. No one seems to have remarked upon this change in the grade at which the maximum destruction of the eyes is found. In fact, the results seemed to have been looked upon as rather accidental and of no special significance.

Some months ago I asked myself these two questions. Is the maximum destruction of the eyes of the school children reached earlier than formerly? Secondly, if such is the case, what is the cause of it? In attempting to answer these questions I have tried to learn what recent investigators have found concerning eyes, and I have attempted personally to examine the eyes of children in schools which were significant. The data which I have secured lead me to conclude that the excessive destruction of the eyes begins several years earlier than was formerly the case in America, and earlier than is still the case in Germany and other foreign countries. As to the cause of the early injury of the eyes the results of my investigations are most significant. The highest per cent. of defective visual acuity I have thus far discovered was found in a room in which the pupils had been in school but 1½ years. This is the room referred to above in which the average number of books read by each pupil during the preceding 12 months was 22. It may not surprise you when I tell you that 84 per cent. of these little innocents had defective vision. The school room in which they were seated was unusually well provided with windows and had a south exposure. Unfortunately their teacher preferred a rather dimly-lighted room and made generous use of opaque shades with which the windows were provided. The light by which the pupils read in school was in most cases certainly better than the light which they had for their reading of books at home. Some of these children in their childish ignorance took books to bed with them, and upon awakening in the morning read before breakfast. It is probable that in most cases the children at home read during the evening twilight till it was too dark to tell one word from another. Then they would retire to some dark corner of a dimly lighted room and continue the reading till supper time or bed time. Young children have no regard for their eyes and parents are not likely to interfere with them as long as they are quiet.

The pessimistic forebodings expressed in the first part of this article are more than justified by the figures just presented. The eyes of our school children are being destroyed, and worse than that, the destruction is now taking place at the age of from 7 to 9 years, which makes the matter so serious that we should bestir ourselves to lessen the evil as far as possible. In the palmy days of Greece the Athenian boy was not taught to read till he was ten years old. By our modern improved form of education we injure the eyes of our children so that one-half of them have defective vision before the age at which the Greek boy learned his alphabet.

The gravity of the situation is so great that I venture to offer in conclusion the following suggestions:

1. We should recognize the fact that human eyes are ill adapted for reading, writing and drawing for a long period at a time.

2. We should recognize the fact that the normal daily deviation of daylight is so great that any method of adjusting the window shades from mere habit is inadequate.

3. In constructing school houses the window space should be as large as that described above.

4. The interior walls and ceilings should be light.

5. The amount of sky visible from each seat should be large.

6. The windows should be provided with white Holland screens or their equivalents.

7. Every school room should be provided with light shades and they should be placed over the black-boards as soon as there are dark corners in the room.

8. School children's eyes should be tested annually and parents notified that an oculist should be employed in the case of all defective eyes.

9. Children should not be taught even the elements of reading or writing during the first year of school. For the ordinary reading and writing should be substituted more oral instruction in language, number work, nature study, history, singing, physical training, play and other forms of training suited to the needs of the pupil.

Foreign Items

Compiled by J. S. Dow.

The recent papers before The Illuminating Engineering Society at Boston have attracted a considerable degree of interest, and have been reproduced and commented upon in many of the European technical journals. As, however, these papers have naturally been fully dealt with in The Illuminating Engineer, there is no need to discuss them further in this article.

These have many items of interest which may be said to fall under the heading of electric lighting. *The Electrician* (Sept. 20th) prints a description of the new Westinghouse arc lamp, which is, however, only made in America at present. This is a luminous flame arc lamp, which, it is claimed, is twice as efficient as the ordinary arc, but nevertheless yields a white light. The positive electrode merely consisted of a copper slab, the negative electrode of metallic oxides, the composition of which is not stated but which we presume to be very similar to that employed in the "Magnetite" lamps. The negative wastes away very slowy, a 12" electrode being consumed in 150 hours, but the chief point of interest is the design of the ventilation of this lamp. The currents of air are arranged so as to carry away the "red fluffy oxide," the deposition of which on globes and electrode has always been a nuisance in lamps of this class, and the current of air is also said to assist in keeping the arc central.

The metallic filament lamps are, of course, also the subject of much discussion. In *Electrical Engineering* (Sept. 13th) a summary of the recent British patents, No 18,749 and 25,978 of 1906, taken out by the British Thompson Houston Co., are dealt with.

The first patent refers to the manufacture of filaments composed of refractory and possibly also non-ductile material, incorporated with a ductile alloy, the resulting product being sintered together by the passage of an electric current either before or after the mechanical manipulation of the material. The second patent relates to the use of Boron in incandescent lamp filaments. Boron is obtained from the nitride by direct decomposition at 2000° C., but in a condition very different from the Boron described in text books; it is conducting and can be melted at a very high temperature without direct volatilization.

An important paper by Mr. Gaster before the British Association in August dealt very fully with the most recent developments in metallic filament electric lighting (reported *Elec. Engineer*, Aug. 16th, 1907, p. 230).

Mr. Gaster dealt in turn with the metallized filament, and the Nernst, Osmium, Kuzel, Osram, Zircon-Wolfram, and Helium lamps. It is interesting to learn that progress is being made in the improvements of Nernst lamp mechanisms, and that eventually these lamps may be so devised as to light up immediately they are put in circuit. Another notable advance has been made by the manufacturers of the Zircon-Wolfram lamp, in producing a lamp in which the filaments are mounted on spring hooks, in such a way as not only to reduce the number of breakages to a minimum, but enable the lamp to be burnt in any position.

Mr. Gaster also commented on the fact that the present inability of manufacturers to supply metallic lamps of

low candle-power and high voltage, was in reality a blessing in disguise, in that it enabled the introduction of these lamps to take place gradually, while the sudden and complete introduction of lamps of this class everywhere would very seriously inconvenience electrical supply companies.

In concluding, Mr. Gaster referred to the progress of illuminating engineering in the States, and the prospects of still further possible improvement in our present inefficient methods of light production.

Herr Klingenberg's recent paper on Electric Lighting in Germany (*Elec. Engineering,* Sept. 19), also invites brief comment. The author considers that the very frequently expressed conviction, that the introduction of metallic lamps will drive the supply companies back to the use of 110 volts for distribution, is wrong. He himself favors the retention of 220 volts, and believes that metallic filament lamps for this voltage will eventually be made. He also refers to the probability of metallic lamps replacing the miniature arc lamps. In reality it is not worth while to make arc lamps of smaller c.p. than 500 now that high efficiency glow lamps with c.p.'s intermediate between this value and the c.p. of the carbon incandescent lamps are available.

F. Stroude (*Elec. Engineer,* Sept. 20), suggests a possible explanation of the wellknown corrugation of tantalum filaments on alternating currents. He emphasizes the fact that these irregularities only occur in the case of the only modern drawn-wire metallic filament. Edison in 1845 devised a drawn-wire platinum-iridium filament which showed similar peculiarities. This lamp was intended to be run on a voltage sufficient to fuse the wire-filament, and this was accomplished as follows: by the time the temperature of the filament had risen to a dangerous value the expansion enabled a spring to intercept the circuit; the filament then cooled again until its temperature enabled the circuit to be re-established, and the cycle of operations was repeated. The filament thus passed through a cycle of temperatures similar to that which the tantalum lamp must be supposed to undergo when subjected to an alternating current, and became corrugated in a very similar manner.

Edison, however, ascribed this effect to the explosive expulsion of gases occluded in the filament, and he found that filaments which had been subjected to a preliminary treatment involving the gradual expulsion of these gases, afterwards showed no corrugation. The author, therefore, suggests that the tantalum filament becomes deformed because of the violent expulsion of gases concealed within it; we might explain the curious local blackening of the bulbs of tantalum lamps on the supposition that the violently expelled gases carry out with them particles of metal from the filament which are projected against the sides of the lamp.

In the *Zeitschrift für Beleuchtungswesen* for August 30th, the researches of Kuch and Retchinsky on the mercury vapor lamp are dealt with. Some curves showing the connection between efficiency of light production and load, both for visible and ultraviolet light, are given. It is interesting to note that the shape of the curve is the same in both cases. For a certain lamp run at a certain voltage, a well-defined maximum efficiency occurs in each case, but the positions of the maxima differ somewhat. With increasing power consumption, however, the light loses its green appearance, becomes yellow and ultimately even red, while the discontinu-

ous spectrum is replaced by a continuous one.

All this is interesting, both as an illustration of the fact that the laws of radiation of an incandescent solid are utterly inapplicable to the luminescent mercury vapor lamp, and also because it seems to dimly suggest the ultimate possibility of a tube source of light, the spectrum of which could be altered at will by comparatively simple adjustment of the conditions within it.

An even more interesting article bearing on the same subject is that of Dr. Otto Vogel in a subsequent issue of the same Journal. The author deals with some experiments of Schott on Electrical Discharge through capillary tubes. This capillary tube in question was about 0.05 millimeters in diameter and 60 centimeters long, and contained rarified gases, which were subjected to the discharge from an induction-coil capable of giving a 25 centimeter spark in air. Under these conditions the gas within the tube became brilliantly illuminated, and Vogel caculates that, theoretically, 2,000 Hefners (.88 c.p.) from a radiating surface of a few square millimeters might be obtained by this method. The tube, however, became extremely hot, even with water cooling, after being in operation about half an hour, and its direct applicability to light production is very doubtful. Yet, Dr. Vogel points out that the results of Schott may prove of useful application to the improvement of other sources.

The remainder of the article is devoted to a review of the present methods of utilizing luminescent mercury as a method of light production. The author states that his own mercury arc, when supplied with 12 amperes at 45 volts, yields as much as 3,700 Hefners. He instances the work of Heräus as indicating that the limiting efficiency of the mercury lamp is not yet realized, and favors the use of tubes of much smaller surface area, and a greater pressure than those at present in use. Dr. Vogel also refers to the remarkable fact that two-thirds of the energy produced by the mercury lamp is produced in the form of ultra violet light. If, therefore, we could only find an efficient way of degrading this energy into a visible form by the use of fluorescent material, the efficiency and practical utility of the mercury lamp might be immensely increased.

One of the chief subjects of interest in connection with gas lighting at the present time is the question of the automatic extinction and lighting of burners at a distance. The great advantage of electric lighting has always been the ease with which it can be switched on and off, and makers of gas lamps are now showing great ingenuity in their efforts to secure a similar advantage for gas.

The *Journal of Gas Lighting* for Sept. 10th, contains a translation of a recent article by Herr G. Kern on this subject, which originally appeared in the *Journal für Gasbeleuchtung und Wasserversorgung*. The article first discusses the application of these methods to indoor lighting. It is admitted that pilot-flames are objectionable for this purpose. They occasionally give rise to unpleasant smells, and, if they are accidentally extinguished, may prove dangerous. Some method which is independent of pilot-flames, such as the "Multiplex" electrical method, is therefore desirable. In this method a small battery excites an induction coil, the spark of which is utilized to light the gas. The gas-cock can also be operated from a distance by electro-magnetic means. Such a method, however, requires supervision; the battery, of course, runs

down in course of time and the electrodes also require occasional attention.

For street lighting and so forth, pilot-flames are open to less objection, though even here they are somewhat wasteful in that each flame burns something like ¼ cubic foot of gas per hour, and they are also liable to be extinguished by wind. The article proceeds to deal with various ingenious devices for the distant automatic regulation of the lights in the streets. These devices involve the use of clockwork or of a wave of temporary increase of gas pressure, or both. The "Bamag" mechanism is said to give excellent results. In this system three impulses of pressure are utilized. The first impulse turns up all the lights at lighting up time, the second impulse turns down those which are only needed for the most busy portion of the night, while the third impulse extinguishes the remaining lights when they, too, have become unnecessary.

The same subject is discussed in an article describing the method of the "Gasfernzünder-Werke," in the *Journal für Gas, Etc.*, of Sept. 14th. The writer discusses the difficulties of the electrical methods. Naturally the electrical current utilized must be kept as low as possible and yet it is not easy to be sure that an electro-magnetically operated cock will be shut perfectly tight by such a current. The method described by the author claims to accomplish this, though only ½ watt is required in order to actuate the mechanism of each lamp. It is also of vital importance that the mechanism should be adequately protected fro mthe weather, and this, too, it is claimed, is secured in the system referred to.

The same journal contains an exhaustive photometric comparison of the merits of upright and inverted mantle lighting by Dr. Hugo Krüss. The upright mantle comes out somewhat better as regards expenditure of gas per M. S. C. P., probably because the heating effect of the rising gases can be more effectually used in this case. On the other hand, the distribution from the inverted lamps is better, the strong downward illumination being advantageous. The comparison of the two methods is also complicated by the part played by the light reflected from the walls and ceiling of the room in which the lamp is to be installed, and the size of the surface to be illuminated, and of course by the use of globes of different diffusive design.

Recent numbers of the *Journal of Gaslighting* also contain a translation of a recent paper by St. Claire Deville before the International Photometrical Congress at Zurich. It is impossible to do more than touch on the general nature of this paper in the space available. Briefly, the author compares the methods of testing the illuminating power of gas in England and France, and deals very exhaustively with the performances of incandescent mantles fed by water-gas, coal-gas and mixtures of these gases. The different methods of testing gas in England and France may lead to very appreciable discrepancies; for one thing, two gases of the same illuminating power according to the English standard, may prove to be very different when measured by the Paris standard.

The light from incandescent mantles naturally varies greatly with the percentage of air admitted with the gas into the burners, but the mixture giving the best results depends upon the consumption of gas for which the burner is intended. Naturally, too, these results are very different for

different varieties of gas, and are also affected by the dimensions of the mantle.

All this renders the rating and photometry of incandescent mantles a very uncertain quantity, especially to those not intimately connected with the gas industry.

No very new photometrical methods have been brought to light recently. Attention may be drawn to the experiments of Lambert with the rotating sector (*Ann. der Elektro.*, Sept., p. 373), who recommends this method for use in the photometry of very intense sources of light, and especially by the "double comparison" method which eliminates both the personal error and the uncertainty as to the exact amount of light cut off by the rotating screen. Also to the form of illumination photometer of W. Bechstein, involving the use of the rotating sector disc in conjunction with the rotating prism flicker apparatus devised by the same observer (*Zeitsch. f. Inst. kunde, 27*, p. 178-183). Also to the experiments on illumination of Weinbeer (*Ann der Elektro.*, Sept. and *Elektro Anz.*, 24, p. 585), who points out that the distribution of most artificial illuminants is rarely such as to promote the ideally even illumination of the horizontal surface beneath them. The polar curve of distribution which secures this condition has an equation approximating to $J = \frac{1}{\cos^3\Phi}$. The polar curve of most sources differs very widely from this equation, and therefore we have to modify the natural curve by the use of reflecting surfaces, or diffusing globes.

Space does not permit us to give the Selenium photometer of Presser and the Rubidium photometer of Elster and Geitel the attention they deserve, and these photometers will be dealt with in a similar review in THE ILLUMINATING ENGINEER for October.

Finally attention may be called to one or two articles of general interest in their bearing on light production. An interesting series of articles have been appearing in the *Zeitschrift für Beleuchtung* on the efficiency of various sources of light. The article in the *Zeitschrift* for August 30th, in particular, gives a very interesting curve illustrating the influence of various percentages of cerium, on the light from the incandescent mantle. The maximum efficiency occurs when 0.9%, about, of cerium is used.

Ladenburg (*Phys. Zeitschrift*, translated in *Journal of Gaslighting*, Sept. 10th), discusses the radiation of the Hefner and acetylene flames. He confirms the conclusion of previous observers that these flames do not conform rigidly to the black body law. Selective radiation shifts the maximum of the energy curve nearer to the luminous region of the spectrum than the temperature of these flames would suggest. He estimates the temperature of the Hefner flame at about 1,430 degrees C. and that of acetylene near 1,838 degrees C. These results are in good agreement with those previously obtained by Nichols and Kurlbaum.

F. E. Ives (*Elec. Magazine*, Aug 30th), has devised what appears to be a useful form of "color-meter." The color of any object is compared with that of a band of color produced by the mixture of the three primary colors in certain definite proportions. By reproducing the exact proportions indicated by the instrument corresponding to any color, we can, therefore, reproduce the exact shade at any future time.

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The Luminous Arc

BY ANDRÉ BLONDEL.

From Bulletin de la Société Internationale des Electriciens.

CONCLUSION.

Contrarily, in the case of arcs between pencils charged with alkaline—earth materials—experience demonstrates that it is advantageous to produce electrovaporization at the anode, because the salts employed impart a brilliant spectrum to the anode. Besides this, the very abundant vapors produced are raised there to a very high incandescence. It appears even of interest to mineralize both electrodes to the limits permitted by the formation of slags, because instead of one, two sources of incandescence are created. But the vapors are a great deal more luminous near the anode, due to the considerable higher temperature of the latter. It is, therefore, more advantageous to accumulate the mineral in the anode. However, the small cathodic cluster or brilliant spot moving around in the fumes is sufficient to make them incandescent in the vicinity of the cathode.

The higher the degree of ionization in the flame, the longer will be the arc and the more the spectrum approaches the elemental spectrum of the basic metal of which the chemical compounds are derived, and the more independent it gets of the electroeralized carbons, the mineral vapors are evaporized in a greater abundance than is necessary for the passage of the current. The excessive non-ionized vapors supply the arc spectrum with continued ordinary incandescence, superimposed on the spectrum of ionized gas. This misled Lenard to the wrong conclusion that the vibrant atoms are not ionized. Finally, the incandescent parts of the electrodes themselves furnish a continuous spectrum. The analysis of a flaming

arc is then an extremely delicate undertaking and a hardly profitable one to introduce here.

Biegon and Szudnochowsky (loc. cit.) have a sketch of the spectrum of calcium fluoride having the rays or band in the red, yellow and green, and also a few of the rays in blue and violet.

The Influence of the Intimate Mechanism of the Arc on the Properties of the Arc Flames.—Their Characteristic Aspect.—According to modern theories electric conductivity is the result of the presence of free ions. Consequently, in order to establish a current between two electrodes, it is necessary that a constant stream of ions should fill up the place separating them. In spite of the apparent character of the carbon arc, in which large quantities of carbon are vaporized from the anode and then deposited on the cathode, the essential rôle in the arc mechanism has to be attributed to the projection of negative electrodes from the upper surface of the cathode. And the vaporization of the anode has to be considered as a secondary and by no means indispensable phenomenon.

The author published a treatise in 1901 on the alternating arc between metals and carbon, in which he proved the impossibility of passing the current on account of the cooling off of the negative electrode during the current-reversals. This demonstrated negative bodies associated with these bases. It is also true that the alkaline salts always impart the color of their base, but it is not the case with earthly alkaline compounds. Fluoride of calcium imparts a color little differing from that of calcium when it is present in small quantities, on account of the ionization then being complete or almost so. Contrarily, when the fluoride is employed in very strong doses and the ionization is poor, as is proven by experiments with alternating current arcs, its incandescent spectrum, where bands predominate, prevails and gives a yellowish white flame, probably due to fluor turning in the direction of green. In arcs of great intensity, or in short arcs, the ionization appears to be feeble, though in arcs of low intensity on account of the higher temperature causing the predomination of simple vaporization raised to incandescence, the light is then whiter in larger arcs than in small ones, and in short ones than in the long ones. Most of the salts, such as the halogen salts, phosphates, sulphates, etc., employed in the arc, undergo a decomposition where products do not recombine except imperfectly. This results in the presence in the arc of abundant quantities of chlore, brome, phosphoric acid, sulphuric acid, etc.—all deleterious and corrosive bodies. Contrarily, the fluorides are found entirely undecomposed in the state of fumes. Experiments executed under the direction of Dr. Wedding even demonstrated that there is only produced fluoride of boron or silicon in the presence of borates or silicates. This circumstance is very fortunate. But it appears that carbide of calcium is produced at the same time with nitrogen peroxide.

In the luminous arcs using metals of the family of titanium, the luminescence is higher at the cathode than at the anode, and the electrovaporization of the anode does not increase the incandescent light, but in a feeble degree, a great deal less than in the case of mineralized (with calcium compounds) carbons. The only solution possible from this point of view would be to employ as an anode a pencil of pure carbon. But the rapid consumption of this anode would overweight its principal advantage of such a lamp, namely: a long life. There is, then, practically left but one thing to do—to employ a cold anode of large mass, of copper for instance. All said here concerning the alternating current arc between carbon and metallic electrodes applies also to flaming arcs. But the difficulty of relighting at each change of phase is such with metallic electrodes that it excludes their employment in the alternating current, as was long ago pointed out by Aarons. It is almost as great (the difficulty of relighting) with the oxides of the iron family and titanium metals. It is, therefore, necessary to employ a mercury rectifier in connection with electrodes of these materials. Contrarily, mineralized carbon electrodes lend themselves readily to alternating current service, even when both terminals are mineralized. The difficulty of relighting expresses itself in the reduction of the power factor. For instance, at the point of the electromotive force curve produced at the moment when the intensity passed its minimum, this power factor does not reach more than about 0.70 for moderately long arcs (38 volts drop across the carbons), but it is possible to reach 0.9 for shorter arcs (22 volts drop across the carbons). The curves in question were reproduced in *Eclairage Eléctriqué,* of March 23, 1907.

Classification of Luminous Arcs Into Two Categories.—From the preceding follows that it is possible from the point of view of the present essay to

classify the luminous arcs into two categories, very clearly differentiated by the nature of the substances employed and the phenomena predominating in the process of the light production. On one side there are the flaming arcs composed of the vapors of alkaline and earthly alkaline chemical compounds or of other compounds giving white fumes, raised to *incandescence.* On the other side we have to do with arcs formed between metals or their compounds of the iron or titanium groups, not enjoying such an advantageous degree of light emissivity by simple incandescence, but which give above all, place to the effect of *luminescence.*

II.—Lamps of the First Category, of Incandescent Flames. (Alkaline-Earth Compounds).—These lamps were realized in practice in three shapes: with electrodes of pure oxides, with mineralized carbons surrounded or not with a protecting outward layer of pure carbon, finally with pencils of pure carbon with mineralized cores containing luminescent salts.

Electrodes of Pure Mineral Substances.—The employment of arc light electrodes composed of pure mineral substances proposed by Raasch and recently introduced in France by the "Compagnie Générale l'Eléctricité" did not seem to develop into an industrial success, and represents at present only a theoretical interest.

The authors used at the ordinary temperature more or less insulating pencils that had to be preheated a certain time. The obtained arc was beautiful, but of a composition less favorable than the arc produced by fluoride of calcium. When instead of the latter other oxides or compounds are added, imparting some conductibility to the mass, the electrodes turn too fusible. However, at any rate the loss of voltage is so considerable, that it occasions an excessive loss of energy. Finally, the voltage among terminals varies so much faster than with other arc light pencils that the regulation would require a precise mechanism. These practical inconveniences are so far not overcome. (Biegon de Szudnochowsky, *Verl. d. Physikalischen Gesellschaft,* 20 March, 1903.)

Typography and the Eyes

After noting as a "curious fact"—though it's certainly a familiar one—that physicians as a class, despite their constant preaching of hygiene to other people, are as little given to hygienic living as laymen of the same social grade, *The Medical Record* considers at length the peculiarities of printed matter in its relation to the human eye. While claiming that its own typography is about right from this point of view, it admits that medical literature as a whole, including both books and periodicals, as much and as persistently illustrates disregard for the requirements of easy vision as do other kinds of reading.

Using as text a recent article in *The Popular Science Monthly, The Record* then proceeds to tell what forms of type, spacing, from of page, etc., assist the reader most or hurt him least, mournfully promising, however, that none of these things has yet been very definitely settled. Perhaps the best size of type, it seems, is that now called in printer's jargon "eleven point," but this takes so much space that readers rarely see it, and the largest used by *The Record* itself is "ten point," and it puts reports in "eight point," the smallest it calls "admissible." This is rather hard on the newspapers, the type of *Times* editorial articles, for instance, being only "seven point," and that of this column "six point."

Italics of any size are condemned as particularly trying to the eyes, while it is held that spacing between lines improves only appearance and that most of it had better be devoted to increasing the size of the type. Long lines are bad, short ones good, since the former increase the work of the eye, while the latter decrease it. Were the type of the same size, therefore, newspaper columns could be much more easily read than book pages, and things like insurance policies are practically unreadable—as everybody knows, the companies not least well, perhaps. Glazed paper, such as often gets into books and magazines because it "takes" half-tone pictures well, much hastens visual fatigue.

Miscellaneous News

CHICO, CAL.—L. D. Macy, proprietor of two local hotels and a man of capital, will apply at the next meeting of the city council for a franchise to construct and operate an electric light and power system in the city of Chico. Attorney G. R. Kennedy is preparing the application for a franchise.

NEW YORK.—Mr. Blackmar, counsel to the Public Service Commission, gave an opinion holding that the Edison Company must stand by all its cut-rate contracts, even if the contracts constitute discrimination, and that other consumers who are paying a higher rate can bring suit in the courts to compel the lighting company to refund to them the excess.

PASADENA, CAL.—The astounding discovery has been made by Superintendent Glass of the Municipal Lighting Department, that the city can save $329,000 by entering into an arrangement with the Sunset Telephone Company whereby the latter corporation will permit the municipality to have the free use of its street poles and certain ducts in conduits, provided the city does not insist upon the telephone company's paying anything for the privilege of doing business in Pasadena.

Superintendent Glass has figured out to his own satisfaction, that the saving of this large sum of money can be insured by prompt action on the part of Mayor Earley and the City Council. He has furnished Councilman Braley and Crandall with estimates showing exactly how this money can be saved, and as less than $200,000 has been estimated by him as necessary to complete the arrangement of the lighting system, there ought to be a net saving to the city of something like $129,000. Mr. Glass has discovered that if the city can make an arrangement with the telephone company for the use of its poles and conduits, more than enough money will be saved to the public to more than offset the total cost of building the electric lighting system.

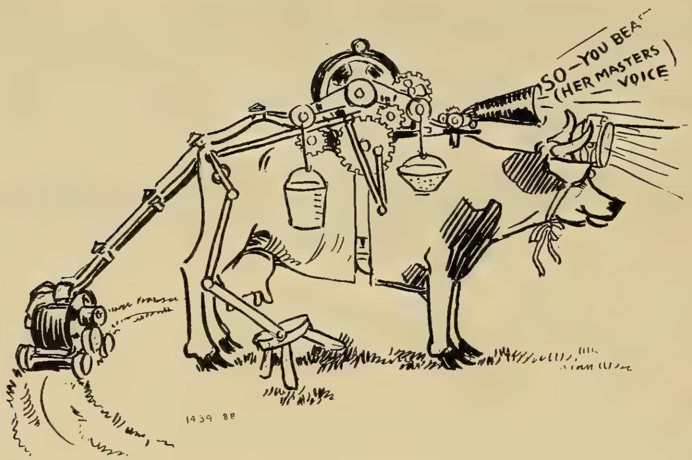
Originally Mr. Glass estimated that the city could with $125,000 install a satisfactory electric lighting system that would prevent the Edison Electric Company from continuing its alleged excessive charges. Bonds for this amount were voted by the people, and the street lighting plant has been in operation since July 4 last. For the purpose of enlarging the plant so that the municipality may also enter the commercial lighting business, the sum of approximately $185,000 has been asked for by Mr. Glass.

By careful and economical management of the lighting plant, large sums of money have been saved each month to the city. According to the reports of Mr. Glass, there has been a monthly saving of never less than $800, as compared with the monthly sums that had been in the past paid to the Edison Company. By further reducing the number of lights in certain sections of the city, it is claimed that even a larger saving can be made each month. If this saving was increased $200 per month, it is easy to calculate that the saving to the city in one year would be $12,000.

SAN JOSE, CAL.—Provided the figures which will be presented shortly to the Mayor and Common Council by an illumination engineer warrant such a step, a bond election will be held in San Jose for the purpose of deciding whether or not bonds shall be issued for the erection of a municipal lighting plant.

The street lighting contract which the city entered into nearly five years ago will expire next summer. The expense of lighting the streets is a very heavy one, and it is believed that a considerable amount of money can be saved if the city maintains and operates its own lighting plant.

Electricity on the Farm



"A Kansas City man has just succeeded in getting a patent on an electric motor fastened on a cow's back, the electricity being generated by a dynamo attached to her tail. It strains the milk and hangs up the pail and the strainer. A small phonograph accompanies the outfit and yells "So!" when the cow moves. If she kicks, a hinged arm catches the milk stool and lams her over the back."—*Osawatomic (Kan.) Globe.*

But he forgot to include a fly-fan.

THE ILLUMINATING ENGINEER

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European vs. American Methods of Street Lighting

By H. T. Owens.

The practice in American cities of furnishing additional street illumination by means of private installations, in contrast with the European custom, was commented upon by Mr. Henry L. Doherty, while he was in London last summer, as follows: "In the United States it is the practice of business people to light the exterior of their premises on a very lavish scale, the whole building being often outlined in points of light. It is the general absence of this sort of thing in London and Paris that has surprised me. . . . . . The street lighting of Paris is very pretty—so far as it goes —but there is not enough of it to satisfy the eye of the man accustomed to American lavishness in this regard."—*American Gas Light Journal,* Aug. 26, 1907.

The writer visited the above-named cities a year ago, and in the case of Paris his opinion is that the lack of additional illumination is the *"Raison d'etre"* for the distinction which Paris has of being the best-lighted city in the world.

The one pre-eminent feature of the street lighting of Paris is uniformity. Mantle gas lamps on very handsome posts furnish nearly all of the illumination. Arcs with milky enclosing globes are to be found at points where traffic is unusually heavy, but you cannot find arcs with clear enclosing globes.

The plan of the streets and the character of the buildings have such an important bearing upon the lighting that a description is necessary to understand the conditions. Most Americans have heard and accepted the statement that the height of the buildings is uniform, but little is said as to architecture and color. The uniformity of the two latter characteristics is much more notable than the one of height. An unbroken line of concrete buildings, all light gray in color, greatly increase the illumination.

The streets are either very narrow or very wide, the latter being known as the "Boulevards." Bracket lamps attached to the fronts of the buildings are used upon the former, and are

FIG. 1.

On the boulevards the amount of reflection is a minus quantity on account of the trees, but the way the difficulty has been overcome was commented upon by Mr. Richard Harding Davis in his interesting and instructive book entitled "About Paris" (1895). "The Parisian raises ten lamp posts to one in New York or London, and he does not plant them only to light something or somebody, but because they are pleasing to look at in themselves."

Figure 1 shows the regular city lamp post, and a bracket lamp may be seen in the distance. The posts are much taller than those used here and much more ornate.

Figure 2 shows one of the ornamental posts in the Place de la Concorde. This square is very large, only a very small portion showing in the photograph, but the several roadways are divided by numerous statues, fountains and walks, so that small lighting units are used very successfully. The

spaced further apart than is usual in the large cities of America (probably 135 to 150 feet). The amount of illumination is sufficient on account of the reflection referred to.

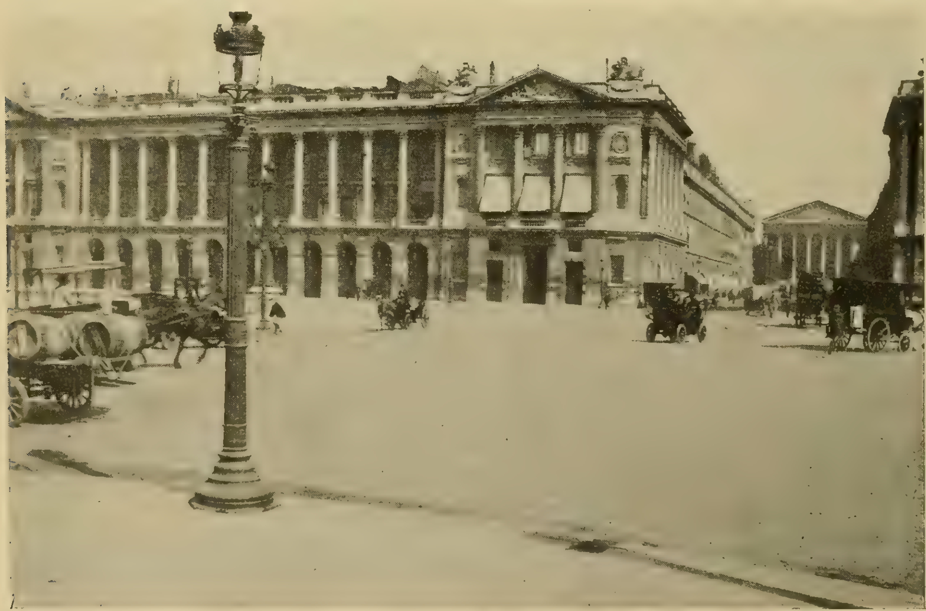

FIG. 2.

FIG. 3.

custom of dividing all large squares in this way is general.

Figure 3 shows the Place de la Madelaine at the intersection of the Boulevard des Capucines. The arc shown here has the usual equipment of milky outer globe, no clear outer globes being used on arc lamps in Paris.

Figure 4 shows an arc upon an isle of safety opposite the Grand Hotel on the Boulevard des Capucines. Mantle gas lamps are located along the curb lines, and arcs, as shown, at each intersection.

The number and condition of the trees along this thoroughfare is quite wonderful when one considers that the location is similar to The Strand of London; Broadway, New York; State Street, Chicago, and Market Street, San Francisco.

FIG. 4.

FIG. 5.

There is one fair-sized illuminated advertising sign in Paris, and its location deserves comment. It advertises a brand of tea, "Ceylon." It is placed on top of a building on the Place de L'Opera opposite the Café de la Paix, as shown in Figure 5.

It has been said that if you sit at this café long enough you will see everyone in the world worth knowing, so that this one evidence of lavishness is admirable. Fortunately it is placed so high that it does not affect the street illumination.

Freaks and Fallacies in Illumination

By "Multipolaris."

The expression, "seeing is believing," is usually accepted at its face value, but, like many other current truisms, it expresses only a general truth, to which there are many exceptions. It is indeed true that one generally believes he sees but contradictory as it may sound, what one sees is not always true. In fact, vision is the most unreliable of the senses. The appearance of ghost and sea-serpents, which have been vouched for in the most positive and emphatic terms by persons of truthful habits for time immemorial, is sufficient proof of this statement. Light, and its effect, illumination, having to do directy with the eye, are peculiarly subject to fallacious misunderstandings. Furthermore, the whole subject has a rather abstruse scientific basis, in consequence of which there is more general ignorance concerning it than any other subject of similar importance. It is a peculiar characteristic of the human mind that it is far less ready to give up ideas and beliefs for which it can give no adequate reason, than those opinions which are the result of thought and investigation; and probably the most exasperating obstacle which the illuminating engineer meets, is preconceived and false notions in regard to the subject of light and its use.

The notion prevailed for years that a sick person should be kept in a dark room. This idea perhaps arose from the fact that beds are very often placed so that light from the windows will shine directly into the eyes of the sleeper, and even diffused daylight shining in this manner continuously would be tiresome to the strongest eyes. There is also a general idea, not by any means extinct as yet, that in the case of sick people and children, that, whatever is is wrong—that what they naturally want to do, that they should not do. Thus, fever patients, because of their intense craving for cold water, were given only warm drinks; and by the same token, since a well person naturally prefers a light room, it was assumed that the sick room should be darkened. Happily this theory has been exploded; sunlight is recognized as the most powerful agent in checking the growth and dissemination of disease-breeding germs. Furthermore, to keep the mind in a cheerful state is often considered of greater importance than dosing the stomach with drugs, and there is no one condition that so conduces to cheerfulness as light. The one precaution that should be followed is to avoid all glare, even the direct light from an unshaded window. If possible, the patient should be so placed as to look out of a window in the opposite direction from which the sun is shining, and all artificial lights should be provided with shades which entirely hide the flame, or other light-source. The question of economy in such cases is not to be considered for a moment.

Eye strain results, generally speaking, from either too dim or too bright illumination. Apparently nothing is simpler than to remedy either of these conditions; if the illumination is too dim, increase it, if it is too intense, reduce it. Strange to say, the exact reverse of this method is very frequently followed. A person works in a dim illumination, and sooner or later finds that his eyes are becoming weak and easily fatigued. He turns down

the light, with the idea of reducing the strain, thereby aggravating the effect; and as the weakness increases, the cause is increased, until his eyes become unfit for regular use in any light. It is a well-known principle that any muscle or organ of the body is strengthened by use and exercise, and weakened by disuse. Carry the arm in a sling for even a few weeks, and it becomes almost powerless. The same law applies to the eyes. Persons accustomeed to indoor life often find open sunlight so taxing as to require the use of smoked glasses, particularly on the water, where there is reflection added to the direct light; while farmers and sailors, who are continually exposed to the direct light, not only find such glasses entirely superfluous, but do not even need the protecting shade of a hat brim, and their eyes are far stronger than those of the city dwellers who habitually work indoors. The proportion of defective eyes, as evidenced by the use of glasses, is far less in the country than in the city, and this is undoubtedly due to the fact that, especially in childhood, the eyes are accustomed to the natural light of day. Eyes weakened by working in dim light should be strengthened by gradually increasing the illumination, and by subjecting them to outdoor light as much as possible. It is needless to say that the change should be made with care, so as not to subject the eyes to shock and strain at first.

On the other hand, eyes are frequently over-strained by being subjected to too brilliant a light, especially from sources of high intrinsic brilliancy. Such strain makes itself felt by a burning or itching sensation in the eye-balls, with the tendency to rub the eyes with the knuckles for relief. In such cases the conclusion is often jumped at that the discomfort is caused by not having light enough; so more is added, thus increasing instead of diminishing the source of the trouble. The right course in such cases is to first see that the light-sources are very perfectly diffused, or softened, and then that the light falls in the right direction. When these precautions have been attended to, it is worth trying a smaller quantity of light; and by trying is not to be understood a mere single look at the objects illuminated under the milder light, but a sufficiently long use of the illumination to give the eyes full opportunity to accustom themselves to the conditions. The restful effect of the milder, dimmer light will then generally make itself apparent. Light is a good thing, but it is possible to get too much of even a good thing.

The opinion is quite generally held, or at least acted upon, that the value of illumination is to be judged by the apparent brightness of the lights when looked at directly; the brighter the light, the better. This opinion is directly contrary to the facts in the case. Except where lights are used for signal purposes, it is never the light itself that we want to see, but the objects upon which its rays fall; and the best illumination of all is produced when the lights themselves are entirely hidden, and only the rays reflected from the objects to be seen reach the eye. In comparing the illuminations from different light-sources it is difficult to get the average person to look at the objects illuminated, and not at the lights themselves, that where such tests are regularly carried out, as in the exhibition rooms of lighting companies, for example, curtains are usually, and always ought to be, provided, which can be pulled down so as to hide the light-sources from direct view.

The law of reflection of light is exceedingly simple, and should be readily understood, and yet there is no fundamental principle of illumination the misconception of which absurd inventions or ridiculous schemes. Sometimes these weird inventions have been innocent blunders; sometimes schemes of that unscrupulous class of persons who are always ready to profit by the credulity of the public, especially in regard to things scientific.

One of the most curious instances of an innocent misconception of the nature of reflected images is to be found in an English patent granted about 100 years ago. The invention consisted in a device for "multiplying and increasing the light" of a gas jet, and was to be applied to street lighting. It consisted of a number of ordinary glass bottles filled with water, which were to be placed around the gas flame at suitable distances. The inventor states that in each of these bottles will appear an image of the flame "nearly as bright as the flame itself," and hence proportionately effective in illuminating the streets. Thus, if four such bottles were used, nearly four times as much illumination would be produced as that given by the bare gas jet. The most amazing part of the performance was the evident seriousness with which the scheme was exploited; that the city authorities who had the street lighting in charge at the time considered the invention to be of practical use is evidenced by the fact that the inventor took out a second patent, in which he states that he makes certain modifications to satisfy objections that were made by the lighting commissioners. It is strange that no one was logical enough to follow the argument to its conclusion, namely, that by using enough bottles a single gaslight jet might be made to light up every street in London.

This idea that light can be increased by reflecting, is one of the most persistent fallacies in the whole subject; and devices are by no means unknown to the trade to-day, which in reality are based upon this principle, though it may not be openly declared. It was not many years ago that a new form of incandescent electric lamp, not one whit more reasonable in itself than the bottles of the English inventor, was made the basis of a stock-jobbing speculation of very considerable magnitude, which even went so far as to buy real estate and put up a fairly large manufacturing plant in an Eastern town. The construction of this wonderful new lamp was as follows: A fluted glass tube was silvered on the inside so as to make it reflect; around this tube the carbon filament was wound, so that when the filament was burning it would be reflected in a wavy line in a glass tube, thus apparently doubling the luminous surface. The fact that tens of thousands of dollars could be secured on such a self-evident fake as this, is a most curious commentary upon the scientific acumen of American investors.

If it were remembered that light is never reflected except at a very measurable loss, no matter how apparent the gain may be, such schemes could not be worked, and a considerable number of devices in which reflectors are used, but which accomplish no other result than the absorption of a considerable part of the light would cease to find a market.

The incandescent electric lamp, with its long, slender filament, which is capable of being coiled up into many different forms, offers another attractive field for inventors, who believe that by using the right apparatus they can lift themselves up by pulling on

their boot-straps. The forms which the filament has been given run the whole gamut from a clock spring spiral to a straight line. It is of course quite true that varying the manner of coiling or looping the filament will make a very considerable change in the manner in which the light is distributed; but this is all. To so arrange the coils of the filament as to give the most advantageous distribution for certain given classes of lighting is perfectly legitimate and scientific; but to claim a greater efficiency, *i. e.*, a greater amount of light for a given amount of current, for some particular form, is either inexcusable ignorance or downright deception. It would seem to be a simple enough proposition for the most untechnical layman to understand, that a given length of filament can only give out a certain amount of light by the passage of a certain amount of current, and that the total amount of light emitted cannot possibly be changed by any particular form of loops or coils. Nevertheless, there is, even at the present time, a three million dollar company being exploited on the "invention" of a lamp having the filament drawn out into a straight line, instead of the usual coiled form, by which simple device, according to the prospectus twice as much light can be had from a given amount of current as from the ordinary lamp. Great claims are also made for the advantages to be derived by the use of a reflector which "parallels the line of light." This is an exceedingly neat expression, and one admirably framed to impress the unsophisticated; but to those who are familiar with the elements of optical laws as generally taught in the common schools, the expression is meaningless. Undoubtedly a lamp having a linear filament has marked advantages for certain purposes, and such lamps have found a considerable sale in Europe, where only legitimate claims have been made for them.

As a matter of fact, the manufacturers of the standard lamp, with its filament looped into a single coil and elongated with an "anchor," cannot be wholly acquitted of at least tacitly allowing an erroneous idea to prevail in regard to the light-power of the lamp. Such lamps give out their rated candle-power in a horizontal direction when the lamp is in the vertical position, but less than one-half this candle-power above and below. Until recent years no efforts were made to inform the users on this point, and undoubtedly the large majority of them at the present time believe that their lamps "give out light equally in all directions," according to the school book statement. The introduction of other forms of electric light which give their greatest distribution vertically has brought about a more general knowledge of the meaning of the term "candle-power" as commonly used, and the fact that light-sources do *not* give out their light equally in all directions. The introduction of greatly improved forms of reflectors has furthered this knowledge. It is now a comparatively simple matter to take any given form of lamp, whether gas or electric, and by the use of a properly designed reflector, obtain within reasonable limits any distribution of light that may be desired.

Nothing is simpler than the use of a reflector placed either over or about a light-source; and yet a great deal of honest effort has been expended in attempts to place a reflector inside of an electric lamp bulb, or to make the bulb itself a reflector. The latter method is legitimate for certain purposes, but the former method is difficult to justify on any scientific grounds. The simple facts of the case are these: the electric

lamp is a perishable article, and must be renewed after a certain number of hours' use. Nothing should, therefore, be added to the lamp which will increase its cost, to accomplish what can be secured equally well with accessory apparatus, which is not thus perishable.

Another misconception that has led to various anomalous devices arises from the difference between regular (mirror-like) and diffused reflection. With a mirror-like reflecting surface, it is possible to calculate a contour which will reflect rays in a given direction from a light-source in a given position. The most familiar example of this is the parabolic reflector used with search-lights. The light from the arc, coming from a very small source, will give, with a carefully shaped reflector, an almost parallel beam of light; but if the surface of this same reflector were painted dead white, the beam of light, instead of being parallel, would shine out in every direction from the open end of the reflector. And yet many reflectors have been designed strictly according to the laws of regular reflection, and then given a white surface; which of course renders all the optical calculations useless.

A practice which is all too common, and which is certainly a fallacy, and a stupid one at that, is the neglect to keep lighting apparatus clean, and in good order. Of course, a person who is generally slovenly in his habits and surroundings could not be expected to be otherwise in regard to his light equipment; but these are not the cases to which we refer. There are plenty of instances in which all the surroundings and other utilities are kept in scrupulous order with the exception of the artificial lights, which acquire a state of decay and filthiness, which are astonishing to behold. We have more than once seen a fine and expensive installation of globes taken down and "scraped," for no other reason than that they had become dirty by long continued use without so much as the stroke of a duster.

A merchant who will have his windows carefully polished every morning, will not infrequently allow his globes and shades, and other accessories of his artificial lights, to increase their burden of dust and grime for months, or even years. As might be expected in the case of anyone guilty of such careless methods, when the illumination is finally reduced to the point where it becomes intolerable, blame is laid on the electric current or gas, and the companies furnishing them. Many companies have found it profitable to furnish regular inspection and attendance to maintain their lighting apparatus at a proper state of cleanliness and efficiency. In the case of illuminating apparatus cleanliness is not only "akin to godliness," but is the own brother of economy, and first cousin to dividends.

The rapid increase in knowledge of the laws of light and illumination, which the rapidly growing movement in illuminating engineering is fostering, must exert a decided check upon the popular misconceptions and fallacies which have so long prevailed. The improvement in this respect is already very marked, and it is incumbent upon all practicing illuminating engineers to take particular pains to see that such "bulls" are not, either from ignorance or malice aforethought, be perpetrated upon an innocent public.

Studies of Notable Instalations

The Plant of the National Cash Register Co.

On the outskirts of the prosperous and well-kept city of Dayton, Ohio, there is a tract of land consisting of some 600 acres, which, to the uninitiated, would be set down as a public park of unusual beauty. In one sense, this surmise would be correct; the tract is indeed open to the public, and has all the beauty that the most skilled landscape gardeners, working on the luxuriously fertile soil of central Ohio, have been able to produce.

FIG. I.—TOOL ROOM.

FIG. 2.—LAUNDRY.

FIG. 3.—ASSEMBLING DEPARTMENT.

FIG. 4.—LOCK AND DRILL DEPARTMENT.

In exploring this tract, the visitor would come upon a collection of buildings constructed of light buff brick, with the largest possible expanse of windows; while velvety lawns, flower beds gay with autumn colors, winding walks and graveled driveways, form the immediate surroundings. Such in brief is the first impression that one gets on visiting the factory where all the cash registers used in this country are made. It is one of the most remarkable institutions in the United States—or for that matter, in the world. "Institution" is a better designation of it than factory, for it is no mere rhetorical flourish of words to say that the manufacture of cash registers is only one of the purposes of the concern; the visitor would be inclined to think that manufacturing was only incidental to their main purpose. There is perhaps no other place in the world, certainly not in this country, where so gigantic and successful an object lesson is presented of the practical, commercial feasibility of combining the highest social (but not socialistic) and humanitarian ideals with the utilitarian necessities of labor. While the details of the efforts which have been made to achieve these ideals are too complicated and foreign to the subject of illumination to justify any attempt at lengthy discussion, we cannot resist the temptation to note some of the more general principles so successfully employed at this model factory.

One of the first points that strikes the visitor, even though the question of illumination were not suggested, is the unusual amount of glass used in the construction of the buildings, and the design and arrangement of the work-rooms to permit the best possi-

FIG. 5.—COMPOSING ROOM.

FIG. 6.—PRESS ROOM.

ble daylight illumination. Not only is the daylight admitted without stint, but every means possible is utilized to diffuse and distribute it after it has entered. The walls and ceilings are invariably of a light tint, usually cream color, and in some instances white. Further than this, all the machinery is painted the same tint, and the aprons and over-garments of both men and women operators are literally spotless white. Even machines using a constant stream of oil on the work, such as automatic screw machines, are painted the same light tint. The women operators are furnished two sets of aprons and over-sleeves a week at the expense of the company; to furnish which there is a laundry that handles 55,000 pieces per week. Ample baths are provided for the use of both sexes, and time allowed employees for their use. A well-cooked and ample lunch is served to the women for 5 cents, and to the men for 15 cents. There are athletic grounds in the park, a circulating library in the building; in fact, with the exception of the theater and the church, there is no form of amusement, or facility for comfort in work or play, that is not provided the employees of this establishment. And the best of it all is the fact that, in the words of the management, "IT PAYS."

The plant is a social and educational institution, but not a charitable institution; and "paying" does not simply mean that the business as a whole produces dividends, which might be due to patent monopoly or other extraneous conditions; it means

FIG. 7.—DRAFTING EQUIPMENT DEPARTMENT.

FIG. 8.—DRAFTING ROOM.

that the system in general pays in the increased efficiency of labor and consequent improvement of the product.

In view of these facts, the study of the lighting of the factory will be all the more interesting, as showing an evolution of ideas and practice, as the system in use is the result of experience. Not the least among the factors that have been instrumental in building up this marvelous organization is the practice of not only soliciting suggestions from both employees and visitors, but of offering prizes for all suggestions that are used, and it is particularly noteworthy that more than one out of five of the entire 60,000 suggestions made during the past year were put into practice.

The lighting of the buildings throughout is by electricity. The system may be described in general as being a moderate general illumination, furnished principally by enclosed arcs, with special illumination for the individual operators, provided by incandescent electric lamps.

Fig. 1 is a view in the tool room, and is a fair example of the general system. It will be noted that each workman has a lamp suspended by a drop cord, and furnished with a reflector shade, so placed as to give the best illumination on his work. Each cord is provided with an adjustor, but there are no other means of varying the position of the lamp.

Fig. 2 shows a portion of the laundry, where the same general system prevails. In this room the ceiling, tables, apparatus, etc., are all enameled white. What with the cheerfulness

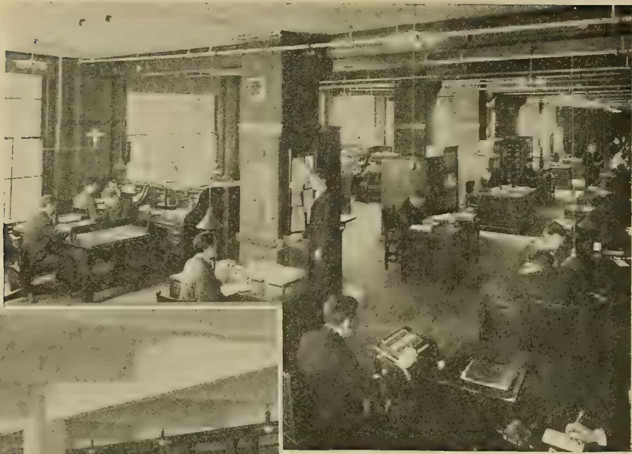

FIG. 9.—SALES DEPARTMENT.

FIG. 10.—NEW SALES DEPARTMENT.

produced by the flood of daylight, the polished floor, the perfect ventilation, the immaculate dresses of the operators, and the smell of clean linen, which Beau Brummell said was the most delightful of all odors, one is ready to believe that the calling of washer-women under the right conditions is really one of the most delightful of occupations.

Fig. 3 is a view in the assembling room. The lamps and reflectors in this case have been temporarily lifted in order to better show the workmen and their work in the photograph. In actual conditions they are dropped to the desired height by the operator.

Fig. 4 shows a section of the shop in which small drilling is done by women operators. The lamp and reflector is hung on the right, and just back of the spindle of each drill, and at such a height as to just hide the lamp from the eyes of the operator. The result is as nearly perfect illumination for the work as could be obtained. To look down this aisle and see the rows of white enameled drill presses, with brass shields polished like gold, with the operators seated on their comfortable stools with backs, in their neat attire and snow-white aprons and over-sleeves, is certainly, in the words of the comic opera, "a cheering sight to see."

A large printing plant constitutes one of the departments in this institution, and in this the same system of lighting prevails. Fig. 5 shows a portion of the composing room, in which it will be observed there is a drop light with reflector-shade hung above the front line of the rack, and at such a height as to hide the lamp

FIG. 11.—SUPPLY DEPARTMENT.

filament. The job press room, shown in Fig. 6, has the lights similarly distributed. Arc lamps are used for general illumination, as will be observed.

Figs. 7 and 8 show the old and new systems of lighting in the draughting room; the older system being by incandescent lamps under the usual shade-reflector, hung comparatively near the board; while the new system is by Nernst lamps in bowl-shaped reflectors hung comparatively near the ceiling. The latter is a comparatively new installation, and has not yet been subjected to a long practical test; the advantages of having the light-sources up out of the way of the instruments is apparent.

Figs. 9 and 10 show the lighting of the old and new office rooms. As will be seen, the former were lighted by the usual method of incandescent lamps, clusters being used for the general illumination; while in the latter case Nernst lamps with opal globes have been substituted for both the general and special lighting. The method of using a general illumination of greater intensity in place of the special illumination formerly employed has not, however, proven entirely satisfactory, and it is not unlikely that individual desk lamps will again be provided.

Fig. 11 is a view of another one of the offices, showing the use of drop lights for individual desks. These lights are hung so that the shade will just hide the lamp from direct vision, and give a light from the right upon the typewriter.

A view of one of the buildings, taken at dusk, showing the interior illuminated, is given on the front cover. The lighting system as installed seems to be generally satisfactory, so far as the factory operatives are concerned. The new office building has been occupied comparatively recently, and the lighting arrangements in it being new, have not yet been so thoroughly tested.

Machine Shops of the Washington Navy Yard

A certain interest always attaches to the methods used by the Government in carrying out any line of work. It is a popular idea that wherever work is to be done for the Government unlimited means are at hand for its accomplishment, and that, therefore, the best services and equipment that money can buy are at the command of the officials in charge. But, like many other popular beliefs, it is very often fallacious; although Congress may vote a billion dollars for keeping the wheels of Government in motion, it very often happens that in the actual details of carrying out the work there is a degree of parsimony practiced which would surprise even the most conservative of private manufacturers. Outside the departments especially created for carrying on experimental work, it is difficult to make even the slightest innovations in existing practices; and, therefore, contrary to what many of us have been proud to believe, it often happens that government methods and facilities are not as advanced as those in private use. This preamble is not intended to imply that the lighting of the Navy Yard machine shops is antiquated, or has not been given careful attention by the proper authorities. It is simply to call attention to the fact that in details government practice is not always synonymous with the most up-to-date methods.

The machine shops in question do not differ materially, so far as the buildings are concerned, from shops for heavy machine work in private plants. The general construction of the buildings is that common to structures of the kind. The buildings are several times as long as wide, two stories in the clear, with a gallery running along either side upon which one or more traveling cranes are supported. In some cases small machine tools and benches are placed upon the galleries, and in some cases also machine tools are placed below the galleries on the ground floor, leaving the heavy machinery for the central aisle. In the case of the large gun shops, however, neither the space below nor above the galleries is used for machines, since the gun lathes requires the entire width of the structure.

The difficulty of properly lighting a machine shop having these structural features arises from the fact that the traveling cranes prevent the suspension of light-sources except at a usual height above the floor, thus limiting their position either to the supporting columns of the gallery or to a position above the traveling crane. In either case it is impractical to produce a general illumination sufficiently high in intensity to provide for the actual work at the machinery, and so special lighting has to be provided. In the shops at the Navy Yard lamps are generally suspended on short brackets attached to alternating supporting columns on each side of the building, and also from the roof as low as possible without interfering with the traveling cranes. The lights in this case are d.c. enclosed arc lamps with opaline inner globes and opal reflectors. This furnishes the general illumination which enables the workmen to see their way about, and to handle the work in the various processes. Besides this general lighting 16 candle-power incandescents, with or without shades, are used by the workmen for lighting the work under the cutting tool. In the galleries which have machine tools and benches, lamps suspended on drop cords are used over the machines, and adjustable swinging

arm brackets for the bench lights. An attempt was made in some instances to furnish sufficiently brilliant general illumination by means of arc lamps to do away with the individual lamps; but the workmen were not satisfied, and the incandescents were generally replaced.

Recently one of the shops in which an unusually fine grade of work is done, namely, that of making breech locks, firing pins, etc., for all the small guns used in the Navy, mercury vapor lamps have been installed to replace both the arcs and incandescents. The shop is 247 feet long and 61 feet wide, thus having a total floor space of 15,067 square feet. It was originally lighted with 23 5-ampere, d.c. enclosed arc lamps, and about 200 16-c.p. incandescents; the whole installation using about 215 amperes at 110 volts, or 23.5 kilowatts. The total estimated c.p. was about 10,000. The present installation consists of 22 mercury vapor lamps, using a total of 11.2 kilowatts. Fifty incandescent lamps are still left in commission to be used if required. The saving in current will thus be seen to be over 50%. The total candle-power is somewhat over 1,600, or an increase of about 60%. The overhead tubes are placed as nearly as possible in the same position as the arc lamps, but those suspended from the galleries between the columns are placed somewhat lower, about 8 feet from the floor. There is approximately 640 square feet of floor space to each lamp.

Judged by the opinions of the workmen, the illumination is much better with the mercury vapor arcs than with the former combination of arcs and incandescents, and the chief electrician is so well pleased with the results, particularly with the economy affected, that he has recommended the extension of this system throughout the shops. While the yard has its own power plant, thus supplying current for lighting at a minimum cost, the saving affected by the installation of the mercury vapor lamps would be sufficient to cut out one of the generating units, which is an economy worth considering.

The problem of the artificial lighting of the shops has received careful attention, and while greater latitude in the way of experiments might enable the engineer in charge to develop some improvements, the methods used are in accordance with what is generally considered good practice at the present time, with an assurance of improvements in the future which will keep pace with the progress of the art.

The following figures show the items of maintenance of the lighting system, which are interesting as showing the magnitude of the installation:

Annual requirements: 10,000 c.p. incandescent lamps; 15,000 arc lamp carbons; 1,000 inner globes; 1,500 sockets; $1,000 worth of reinforced flexible conduit; $1,000 worth of wire lamp guards; $1,000 worth of shade holders; 1,000 10″ tin shades. The total number of employees is about 4,000.

Theory and Technology

Plain Talks on Illuminating Engineering

By E. L. Elliott.

XII.—Industrial Lighting

By industrial lighting we mean the llumination of all classes of factories, works, and shops used in the production of manufactured articles. As will readily be conceived, this class of lighting includes a large number of problems involving widely varying conditions and requirements. Between the yard of a steel plant and the bench of the watchmaker there is indeed a wide range of conditions. Any attempt to classify the subject and lay down hard and fast rules for the different cases would result in very frequent malpractice. There is only one rule to be observed; namely, to study each individual problem as thoroughly as possible so as to determine all the conditions under which the illumination must be produced, as well as the effects required. In our discussion, therefore, we can only take up a few of the cases which are more frequently met with, and make general suggestions as to the proper treatment. We will take up first what may be called the coarser grades of industrial works. The most important representatives of this class are the iron and steel plants.

Probably the most difficult problem of all industrial lighting is the illumination of a foundry. The conditions involved afford an array of difficulties that can scarcely be equalled in any other problem of illumination. For the work of preparing the molds a fairly high degree of intensity is required,—from 1 to 2 foot candles. Since the sand is of a dark and nonreflecting color and the outlines that must be distinctly seen often comparatively delicate. And again, while the "pour" is taking place the generation of steam and smoke is so voluminous as to make an atmosphere that is almost impenetrable; but notwithstanding this it is absolutely essential that the workmen carrying the ladles of molten metal be able to clearly see the aisles and paths among the molds, so that they can move quickly and safely about. In foundries where heavy work is done there is generally a traveling crane running the entire length of the building at a height of some twenty or thirty feet above the floor, which necessitates the placing of all light-sources either above this height, or at the sides of the room. Thus the problem requires that an illumination on the floor of sufficient intensity to enable a molder to work, or a workman to easily walk about among the molds and castings even in the presence of dense smoke and steam, shall be produced from light-

sources placed often more than thirty feet above, or at the sides of a room perhaps a hundred feet wide. Evidently the thing required is a light-source of large total candle-power, and of such composition of rays as to most readily penetrate a murky atmosphere. One of the most successful lights for this purpose that we have ever seen was the so-called "Lucigen" light, which is simply the flame of a burning jet of kerosene oil projected under high pressure. The flame thus produced is of great brilliancy, and produces a large volume of light. It is, in fact, a miniature of the flame from a Bessemer converter, which is beyond all comparison the most powerful artificial light that has ever been produced. In the case we refer to these flames were placed about ten feet from the sides of the room, about twenty feet apart, and five or six feet above the ground. The resulting illumination, even during pouring time, was as satisfactory as could reasonably be demanded under the circumstances. The one fatal weakness of this system is that it requires a system of pipes connected with a tank of kerosene oil under pressure, and the fire underwriters consider this a prohibitive risk. A modification of such a system, which could readily be provided by the use of small individual tanks instead of the general piping system, would perhaps meet this objection; and although we have never seen it used for interior work, yet judging from the results obtained when used for street repair work, we see no reason why it might not afford a feasible solution for certain cases of foundry lighting.

If electricity is to furnish the light, the various forms of arc lamps are the only thing to be considered for general illumination, the incandescent lamp being out of the question for this purpose. The choice will lie between the five different types of arc lamps now available, including the mercury vapor lamp. In order to make an intelligent selection, the general conditions of the problem should first be studied. The points to be considered are: the position of the lamps necessitated by structural conditions; the distribution of light with reference to the position of the lamps; the relative light flux and efficiency of the different lamps; and the quality of their rays.

In founderies using the traveling crane, the lamps must either be hung above this, or on the sides of the room, or in both locations. If there are galleries on the sides, the latter arrangement will generally be necessary. Where there is no traveling crane, the lamps may be suspended at any height desired, either from the roof or from brackets on the side walls.

Beside candle-power and distribution, the question of color is of importance as determining the power of the light to penetrate smoke and steam. The predominant colors of the different sources are as follows:

Enclosed Arc ....Blue
Open Arc ....Slightly Blue
Flaming Arc ....Orange Yellow
Metallic, or "Luminous Arc"..White
Mercury Arc ....Greenish Blue

The advantages and disadvantages of the several types for the different conditions may be summarized as follows:

ENCLOSED ARC (DIRECT CURRENT).

Advantages: Reliability or operation; well known and understood by all electrical operatives.

Disadvantages: Too wide distribution for cases in which it must be hung high; excess of blue and violet rays, which are absorbed by smoke and steam; high intrinsic brilliancy when

used with clear globes, and great reduction in efficiency when this brilliancy is reduced by the use of opalescent globes.

ENCLOSED ARC (ALTERNATING CURRENT).

Less efficiency, and practically equal distribution of rays above and below the level of the lamp, requiring the use of a reflector to utilize the light in the upper hemisphere; otherwise the same as d. c. lamp.

OPEN ARC.

Advantages: Reliability of action; higher total candle-power; greater absolute efficiency; better distribution and better color than enclosed arc.

Disadvantages: Necessity of more frequent trimming, and high intrinsic brilliancy unless dense opal globes are used, which greatly reduce the efficiency and candle-power.

FLAMING ARC.

Advantages: Large flux of light and high efficiency; advantageous distribution; moderate intrinsic brilliancy; orange yellow color of light, which penetrates smoke and steam.

Disadvantages: More frequent trimming than enclosed arc; higher first cost of lamps.

METALLIC, OR "LUMINOUS ARC."

Advantages: Large flux and high efficiency; good color; and, in lamps using the positive electrode above, very advantageous distribution; long burning—at least equal to the enclosed arc.

Disadvantages: Lamps using the positive electrode below have too wide a distribution. A diffusing globe of fairly dense opal glass is an absolute necessity, not only on account of the brilliancy, but to absorb the ultraviolet light; can be run only on direct current.

MERCURY ARC.

Advantages: High efficiency; low intrinsic brilliancy.

Disadvantages: Requires the use of a reflector to utilize the upward rays; liability to mechanical breakage; distinctly colored light, containing no red rays whatever, and a great preponderance of blue and green. Question of the power of this light to penetrate steam and smoke is disputed.

A general survey of their relative merits and demerits leads to the conclusion that the older types of arc lamps have been decidedly out-classed by the two new forms, known as the "flaming," and metallic or "luminous" arc. Of these the flaming arc is now sufficiently well known, and has been put through such practical use under varied conditions as to no longer be in the experimental stage, although it is still undergoing mechanical improvement. The metallic arc is yet commercially an unknown quantity. While some forms of it have been in successful use on a commercial scale in a few cities, it is probable that the majority of electrical engineers have never even seen it. The flaming arc undoubtedly has the lead in its relative advantages and disadvantages for the purpose under discussion, although both the luminous and mercury arcs are still worth considering.

On account of the smoke and dust in the atmosphere, the use of accessories in the shape of globes and reflectors is to be avoided as far as possible. This is especially true of reflectors, since their reflective power will rapidly deteriorate under these conditions. The flaming arc uses a single lightly opalesced globe, but the total flux of light is so large, and the efficiency so high that the absorption is not a serious matter, and is far more than offset by the very mild intrinsic

brilliancy thus produced. Flaming arc lamps are now made to run sixteen to eighteen hours at one trimming, and the globe should, of course, be carefully cleaned at each trim.

Gas lighting is by no means to be despised as a possible solution of this problem. In cases of foundries doing the lighter grades of work, in which there is no obstruction in the way of ceiling lights, the so-called gas arc may be used with excellent results, particularly the newer forms using the inverted burner. This form gives a large total flux of light of good color, and a particularly good distribution without the use of a reflector; and even when used with a clear globe, the intrinsic brilliancy is far less than an arc lamp similarly equipped. Individual inverted gas lamps can also be very advantageously used for special lighting for molders, particularly for bench work. For the latter purpose, an incandescent gas lamp with a reflector so arranged as to throw the light where needed is a vastly better arrangement than a gas jet on a jointed bracket. For bench and light floor work individual lights should usually be provided, either gas, as noted, or incandescent electrics. In the latter case, they can generally be provided with a temporary support, by means of which they can be placed in any desired position.

Rolling mills present a comparatively simple problem. A fairly good general illumination is required, which can be satisfactorily produced by any of the forms of arc lamps, the particular type depending largely upon the condition of structure, and kind of current available. Circumstances permitting, the newer types—either the flaming or the metallic arcs, would give the best results. As direct current is usually to be had in such cases, the metallic arc would be well worth careful consideration for the purpose.

Heavy machine-shops often present difficulties in the way of placing overhead lamps, arising from the use of traveling cranes, that are met with in foundries. The smoky atmosphere, however, is absent; but on the other hand, there is need for better special illumination, as blue prints must frequently be read, as also micrometer gauges, besides the necessity of distinctly seeing the cutting tool. The general illumination may, therefore, be somewhat less, from one-half to one foot-candle—with the provision of special lights for the individual workman. In the selection of light-sources for the general illumination, the considerations that hold in the case of foundries will apply without particular deviation in machine shops of this class. The yellow light of the flaming arc should be particularly favorable for reading blue-prints, since it would make the blue appear nearly black, thus increasing the contrast; although for this purpose it would probably not surpass the mercury vapor lamp. The question of intrinsic brilliancy, or glare, however, is much more important in machine shops than in foundries. The murky atmosphere of the foundry is in itself a diffuser of light; furthermore, the workman in the machine shop is commonly standing erect, so that glaring light-sources fall more directly in the line of vision. Carbon arc lamps, even with lightly opalesced globes, should be avoided if possible. It must be remembered that "glare," which is the common name for the visual effect produced by an intensely bright spot on the retina of the eye, does not diminish as the square of the distance from the source, as does the general illumination, but keeps the same brightness whatever the distance of the light-source, varying only in size; so that a bright light, even at a

considerable distance, will prove troublesome in this respect. A distant light will not fatigue the eye as quickly as the same source nearer, but will have the same general result if encountered for any considerable length of time.

To provide an individual electric lamp for the use of each workman is not so simple a matter in cases where there is no opportunity for overhead support. Thoroughly satisfactory results, however, require the use of such lights, and they should therefore be provided by the best means available. Outlets should be liberally provided at all convenient points for the purpose of supplying local supplementary power, as well as light. An incandescent lamp attached to a handle, and if necessary protected by a wire guard, is an incomparably more effective portable light than a candle, or the old vile-smelling, dirty, smoking torch. The problem of supporting such a portable lamp so as to give the right illumination on the work may require some ingenuity; thus, in the case of large lathes, where the tool may travel anywhere from two to thirty feet, it is necessary to provide a corresponding change of position for the light. This necessitates its being attached to the tool carriage. Some time ago there was a device exhibited consisting of the simple arrangement of a lamp socket connected in series with an electromagnet attached to an iron base. The device would, therefore, hold itself by magnetism to any iron support. The idea was clever and seemingly practical, and it is a little curious that the device has never reached the commercial stage.

Machine shops in which the lighter classes of work are done, and which therefore do not require traveling cranes, present a much simpler problem in illumination. The general practice is to provide a mild general illumination and special lights for the workmen. In some cases, however, a general illumination of sufficiently high intensity to do away with the use of special lights is aimed at; but of the two methods we should certainly prefer to trust the former. As the ceilings of such shops are of ordinary height, the use of arc lamps without globes sufficiently dense to give good diffusion, or clusters of bare incandescent lamps, is more objectionable even than in the case of larger works, and should be generally avoided. Undoubtedly the best method of securing satisfactory diffusion and distribution with the carbon arc lamp is by what is known as "indirect illumination," which is accomplished by reflecting the light either from a white ceiling, or from a large white reflector placed above each lamp. The latter is the better arrangement, as reflectors for this purpose are standard articles in the trade, and being made of enameled sheet iron are very easily cleaned, and do not deteriorate in reflecting power. The use of this device has been successfully carried out for producing a sufficiently high degree of general illumination to avoid the use of special lights, except for exceptional purposes.

The mercury vapor lamp is finding much favor as a source of general illumination for this class of work; and while it is not best to depend upon it to entirely supplant local lighting, it is possible to greatly reduce the number of special lamps required. The peculiar color qualities of the light seems to be rather advantageous than otherwise for machine-shop use. It shows blue prints admirably, and also, on account of its lower intrinsic brilliancy and larger luminous surface, gives an illumination on the bright surface of freshly cut metal that is

free from brilliant reflections and sharp shadows. Gas arcs would also give a very satisfactory illumination for the purpose.

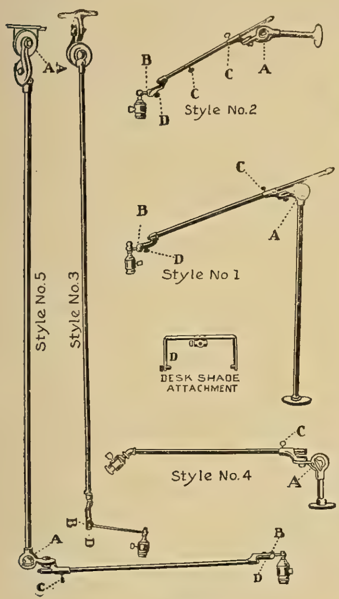

FIG. 3.

FIG. I.

The special lights for machines in which the tool remains practically stationary, such as milling machines, drill presses, planers, and small lathes, may be given a permanent position that will be satisfactory by simply suspending them from the ceiling on a drop cord. Some simple device for varying the height should be used, and an arrangement for tilting the reflector (see Fig. 1), would also be useful in many cases. This simple device has the advantage of allowing the reflector to be used in its ordinary vertical position whenever desired. Instead of using a tilting device, a reflector made to throw the light down at an angle, as show in Fig. 2, may be used. Jointed supports attached to the ceiling, a good design of which is shown in Fig. 3, have the advantage over the drop cord of enabling the lamp to be moved about over a considerable area, fixed so as to point in any direction, and readily thrown out of the way when necessary. In the cast of lathes these advantages are sufficient to justify the additional expense of such fixtures.

Electric lamps used for special lighting should in practically all cases be provided with some form of reflector shade. The best material for such reflectors is sheet aluminum. It has the advantage of being exceedingly light in weight, non-breakable, non-rusting, easily cleaned, and, when finished with a matt surface, is an exceedingly efficient diffuse reflector. The next best thing is a sheet metal reflector properly coated with aluminum paint. Tin reflectors painted white on the inside and green on the outside are cheap and in common use; but the white paint very soon deteriorates, becoming soiled and scaling off, and is very difficult to clean without damage. Shades of green and white cardboard are cheap and effective so long as they last. Celluloid reflectors are dangerously inflammable. Opal glass reflectors are efficient but too easily broken, and the same objection holds with other forms of glass shades and reflectors.

A good illumination for bench work is easy to produce, and there is absolutely no excuse for such workmen

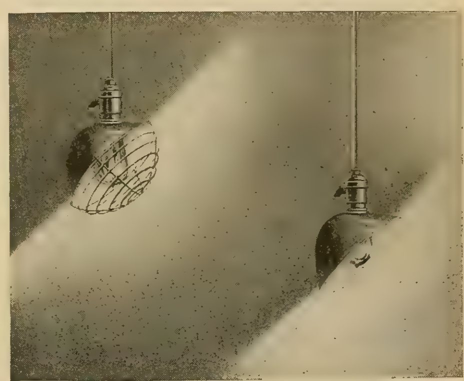

FIG. 2.

being handicapped by poor light. Perhaps the most satisfactory device in such cases is an adjustable wall bracket. A fixture capable of universal adjustment, and which may be used either as a wall bracket, or attached to the back of the bench, is shown in Fig. 3.

In nearly all cases of special lighting a sixteen candle-power lamp with a good reflector will be ample. In fact, if economy of current were any object, an eight candle-power lamp kept in good condition would generally suffice. In cases of very fine bench work, however, such as die-sinking and the like, a stronger light may be profitably employed. In this case care should be taken to prevent a streaky or spotty illumination, it being advisable in some cases to use frosted lamps. The eyes of a mechanic are of paramount importance. No matter what his manual skill and dexterity may be, or how faithfully he may work at his allotted task, the quality of his product is absolutely limited by his distinctness of vision. The resort to eye-glasses in the case of clerical work is a comparatively small handicap, but the same is by no means true in mechanical work, as their use interferes with both the quantity and quality of product. To subject a mechanic, therefore, to the direct glare of any of the modern light-sources is to gradually deprive him of that which renders his labor a means of support for himself and of gain to his employer.

The business short-sightedness, to say nothing of the disregard of the feelings of humanity, which is sometimes exhibited by superintendents or owners of manufacturing plants, is worse than gross stupidity. The following incident given by a manufacturer of lighting apparatus will serve to illustrate this sort of fallacy. A manufacturer was induced to have a sample lighting device, which was very simple and inexpensive, but effective for the purpose,—put up on trial for one of the workmen. After a short period of use, the maker of the device called upon the manufacturer with the expectation of receiving an order, but instead he was requested to take out the sample immediately, for the reason that if it was allowed to stay in place every other workman would want one! Another case that came under the writer's direct observation, was that of a factory superintendent who had the lower half of the windows glazed with obscured glass to prevent the operatives from looking out. Were it not for the fact that a large majority of the really progressive and successful manufacturing concerns have realized the fact that regard for the welfare of employees is an actual dividend-paying policy, such examples as those noted would strongly tend to destroy all faith in human nature.

In conclusion, we would point out to the manufacturer that both machine and hand tools have been brought to a high state of perfection, but no matter how nearly perfect the tool may be, or how competent the workman, it is unreasonable to expect the best results, either in quantity or quality, unless the workman can see what he is doing clearly and without fatigue to his eyes; and that the cost of installing and maintaining the best possible system of illumination is the best-paying investment that he can possibly make.

Industrial Gas Lighting.

By T. J. Litle.

The above title would convey to the lay mind the use of a large number of open flame burners with a scattering of incandescent gas burners, for the simple reason that he has seen a number of shops so lighted.

At the present time, however, great progress is being made by the proper adaptation of the incandescent gas burner, both of the upright and inverted types.

The old idea that the mantle was impractical in places where there is a great deal of vibration has been disproven by a large number of installations of gas arc lamps and pendant burners supported on some anti-vibrating device, such as Fig. 1, so that at the present day we find that there is not a single case where it is not feasible to apply this form of lighting where these shock absorbing devices are intelligently used. The economy of the system has always been conceded; the difficulty arose from the fact that they were never properly maintained. Recently, however, there has been a growing tendency on the part of the gas companies in this country to take this work over. This has been done quite generally in Europe, and where the incandescent gas lamps are properly maintained the lighting results have there proved satisfactory.

The lighting of a modern manufacturing plant may be considered under two general headings: First, the general illumination of the shop, and, second, the concentrated illumination over the machine or bench.

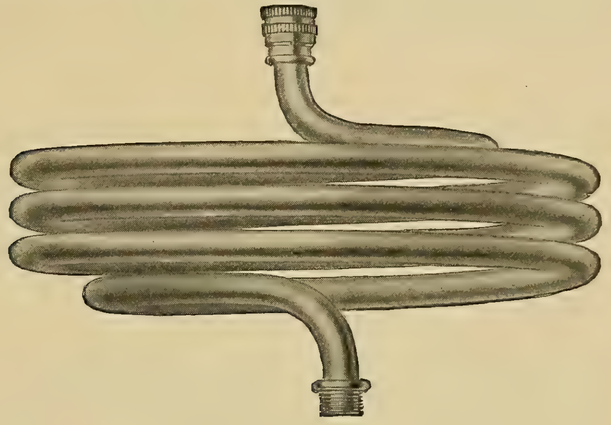

FIG. I.—SPIRAL ANTI-VIBRATION FIXTURE.

GENERAL ILLUMINATION.

In every part of the plant general illumination is necessary: First because there is always work of a transient nature, where the operatives have to move about from one place to another and where a liberal illumination of machinery is necessary. There is further no doubt that such liberal illumination helps to keep the workmen cheerful. Such illumination is good from the foreman's standpoint, so that he can keep his eye on his workmen—with no dark corners for sky-larking.

I have frequently been in plants where the general illumination had been neglected to such an extent that

FIG. 2.—SHIPPING AND PACKING ROOM.

every workman seemed to be working in his own little sphere of illumination; surrounded by a general gloom which has a depressing effect.

The gas arc meets this condition admirably. Each lamp is a separate and distinct unit, entirely independent from every other lamp for its operation, and the most pleasing effect is obtained by the use of a pear-shaped alabaster globe which eliminates the direct glare from the mantle and yet gives a soft, but powerful, diffused light, the distribution of which is almost perfect. White paper, if laid on the floor beneath the lamps, or held at any angle from the lamp, clearly demonstrates that there are no shadows distended from the parts of the lamps themselves.

These lamps are lighted by the simple pulling of a chain, the operation turning the gas on the four burners, at the same time flashing a jet of gas which ordinarily is a very small pilot flame. This flame, in flashing, is about four inches in length. This enables the lighting of any lamp, independent of any of the others at any time of the day and this, in itself, is important inasmuch as there are always certain points in every plant which require occasional lighting. With this system of lighting the same high efficiency is obtained with but a single burner operating in a plant as is obtained at the peak of a load.

Fig. 2 illustrates the packing-room of a large plant where this system is installed. In this particular instance the general illumination becomes the only illumination as the men have to work in all parts of the room in every conceivable position. This includes the packing, case marking and trucking in and out. The importance of the general illumination is again indicated by Fig. 3, which shows a corner in a case factory. In this instance the men not only have to saw and work up the lumber, but also to carry it from one point to another and assemble the various parts. This work is of a general nature and it is found quite impossible to properly light the room with small individual units.

FIG. 3.—CORNER IN CASE FACTORY.

When it comes, however, to lighting machinery, it is generally found necessary to use the smaller units over every machine, in addition to the larger units previously described. Fig. 4 gives an instance of this. The illustration shows a corner in a tool room of a large plant where strong illumination becomes imperative. In this case the inverted gas light is used. To eliminate the destructive vibration which is found in such a room the lamps have been suspended from flexible metallic tubing from the beams above

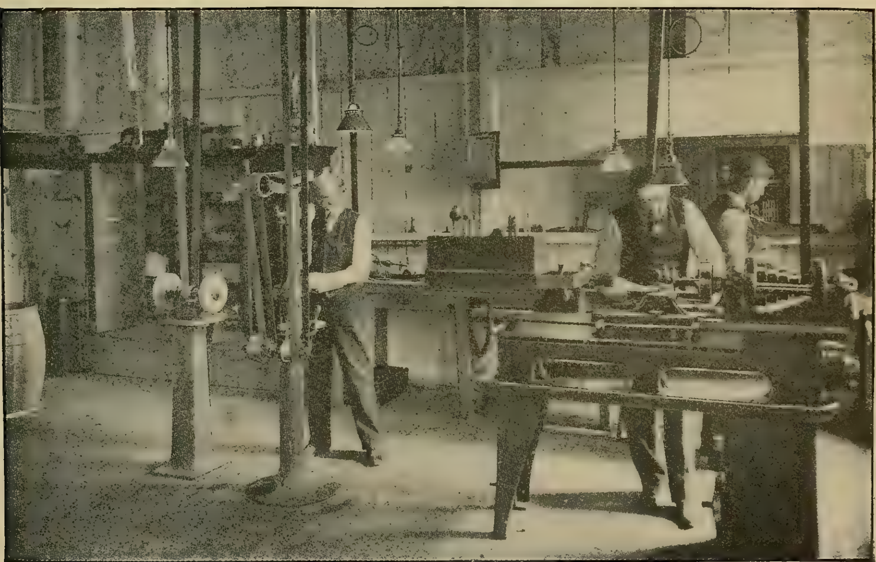

FIG. 4.—GAS LIGHTING IN TOOL ROOM.

FIG. 5.—INVERTED GAS LIGHT OVER SHOE MACHINE.

and in this case the rapid vibration, which is usually found in the machine shop, is entirely taken up. The only effect noticeable is at times a slow swaying motion which has no effect on the mantle. The use of this flexible pendant has been extended to make it a portable light as well. This is accomplished by attaching the upper end of a flexible tubing to a swing gas bracket, such as is commonly in use in residences so that the light can be pulled from one point to another over the bench. Its use is further extended over lathes by the fact that it may be tilted at an angle for momentarily inspecting work in the chuck or jig.

Fig. 5 shows more clearly the individual application of this form of light over a shoe machine. The illumination from the above burners is high, but, as the reflecting shades are so arranged as to protect the eye, the effect on the workman is most pleasing. High illumination on the machine is always desirable providing, of course, the eye is directly protected from the glare and further provided that the lamps are so placed to one side of the work rather than directly in front, thus avoiding reflected light entering the eye. A very important, self-lighting appliance is used with these inverted burners in the shape of a by-pass. A very small pilot flame is maintained close to the mantle, while the gas supplied to the burner is controlled by a fiber thumb-piece directly above, eliminating the use of matches.

OFFICE LIGHTING.

The lighting of the office must be considered along with the lighting of the plant and is a subject which is often overlooked by the management. A great deal of care is taken in properly

FIG. 6.—INVERTED BURNERS FOR OFFICE LIGHTING.

placing the lamps through the works, so that the workmen may operate to advantage while the office force have to make out as best they can with some nondescript lighting which perhaps was laid out for an entirely different force at some previous time but which, owing to some subsequent arrangement of the office furniture, is now entirely inadequate, causing headaches and other troubles directly due to eye-strain from unsuitable lighting—a poor policy, indeed.

Fig. 6 clearly shows a general installation of reflex gas lights. The lamps on the chandeliers are hung quite high so as to be above the general range of vision, while the typewriters and clerks are further provided with individual burners so placed that the eyes are protected by the reflecting shades, at the same time being located at one side wherever possible to prevent the reflected light from the paper reaching the eyes. In this particular instance it will be noted that the chandeliers in use were originally intended for upright burners but were converted for use with the reflex burners by the simple adaptation of the goose-neck. In this particular instance the fixtures may be considered fairly ornamental, but there are many cases where the matter of fixtures is sadly neglected. No expense is spared to furnish the office with mahogany desks, and other fine furniture, and railings are commonly in use, but the lighting fixtures are atrocious—due, no doubt, to the fact that no attention had been paid to the artistic requirements of illumination.

Special fixtures for these reflex lights have been designed which well meet the requirements of the modern office, as shown below.

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Industrial Lighting

In no other case is the question of illumination of such economic importance as in the lighting of industrial works. An ill-conditioned light in the home will produce more or less discomfort and inconvenience to the members of the household, and occasion some slight monetary loss. An inefficient lighting system in a public building has the same result, merely affecting a larger number of people and a larger monetary loss. But in the case of bad lighting in a factory or work-shop the personal inconvenience means a reduction both in quality and quantity of output, thus producing a loss in comparison with which the entire cost of illumination is trifling.

Any reasonably intelligent manufacturer will at once admit that poor tools and machinery are the most expensive equipment which it is possible to use. It is to the marvelous approach to mechanical perfection achieved in American machinery that enables our manufacturers to sucessfully compete in the markets of the world with the products of far cheaper rates of wages. The relation of labor to improved machinery is admirably expressed in the following words, which are prominently displayed among the various legends posted about the works of that representative American establishment, the National Cash Register Company: *"Improved machinery makes men dear and the product of their labor cheap."* American labor at the present time is receiving the highest wages in the world's history, and hence the importance of so regulating the physical conditions under which the laborer works that he may produce the utmost results of which he is capable. Pick up any manufactured article you please, consider the elements making up its total cost to the user, and you will at once see what a large part of this cost is due to labor, and how comparatively small an amount to the cost of "raw material."

The workman is guided in his labor almost exclusively by the sense of sight, and the importance of furnishing a good illumination is so apparent that it would be a mere waste of words to discuss the topic, were not the fact only too plainly apparent that in many cases this axiomatic truth is sadly overlooked. Even daylight, the perfect illumination, and of which

there is an infinite supply to be had, is frequently used in a most niggardly and thoughtless fashion. Workshops are crowded into the congested portions of cities where sunlight is at a premium; and it is only in comparatively recent times that buildings erected for this express purpose, and located in the open, have been designed with a special care toward affording the greatest possible access of daylight illumination. Fortunately, however, the strictly modern factory building has its side walls largely of glass. In addition to thus affording the largest possible opporounity for the admission of sunlight, the ceilings and interior walls should be, and generally are, painted white or a very light tint, which materially assists in the diffusion of the light. It is beginning to be recognized that even machinery may be given a light color instead of the dark gray or black that has so long prevailed. Not only does the room thus flooded with daylight afford better conditions so far as mere seeing is concerned, but gives an air of cheerfulness and cleanliness which are factors of economic importance.

While the greatest possible use should be made of daylight illumination, artificial illumination is an absolute necessity to a greater or less extent; and in the arrangement of the lighting installation no pains should be spared to secure the best results which modern science has rendered possible. To furnish the most up-to-date machinery and tools, and pay the present high prices for labor, and then to handicap the workmen by insufficient, or improperly placed lights, is a fallacy too patent to require argument; and still such cases are by no means uncommon. It will perhaps add to the impressiveness of this statement to again make use of a few computations. Let us take as a basis the electric light, which is admittedly the most expensive form of artificial illumination, and let us say that the current is purchased at the retail price of 10 cents per unit (kilowatt hour). A 16-candle-power lamp can be burned 18 hours by the use of one unit, that is, at a cost of 10 cents, or 55 mills per hour. The ordinary workman, receiving, say, 20 cents per hour, would only have to lose a trifling over a minute and a half out of an hour to represent a loss equal to the cost of the light; while a skilled workman, receiving, say, 50 cents per hour, would have to lose only a little over half a minute every hour to represent a similar loss. In other words, the ordinary workman losing 13 minutes in a day of 8 hours, or the skilled workman 5 minutes in the same time, would equal the cost of running the lamp for the entire working day. But instead of electricity costing 10 cents per unit, it may be generated in large works, where power is already at hand, as well as the fixed charges of superintendence, etc., required for its generation, the current can be produced as low as 2 cents per unit, which would reduce the above figures to one-fifth; that is, the common workman would have to lose only about 2½ minutes in an entire working day of 8 hours, and the skilled workman but a little over a minute, to represent the cost of the lamp for a day.

But the loss in wages is not all; loss in time of the operative represents a loss from the non-use of the machine. And again, besides there being a reduction in the amount of product, there is often a reduction in quality also, which is far more serious than the reduction in quantity. This matter was investigated several years ago in an English cotton mill, where it was found that an improvement in the lighting not only increased the output

measurably, but very greatly reduced the amount of "seconds" turned out, thus adding to the value of the product on both accounts.

The cost of the most elaborate lighting system is furthermore a very small item in comparison with the cost of the mechanical installation. An electric lamp suitably placed could, in the majority of cases, be provided at a cost not exceeding $5.00. If such a lamp is used with the average machine tool, such as lathe, planer, etc., the cost of which would be from $50 to $1,000, the relative cost of installing the lamp would thus be only from 10% to one-half of 1%; the average probably not exceeding 1% of the cost of the mechanical equipment.

In many cases a lighting installation which would be adequate if properly maintained is allowed to run down and become seriously defective for lack of care. We have seen electric lamps and reflectors taken from machine shops, with the reflector absolutely black from accumulated soot and grease, and the lamp showing a mere "red hot hair pin" on account of age and the grime on the bulb. The maintenance of the lighting system should not be left to the individual workman. The expense of the necessary labor to regularly inspect, clean, and keep in order the lighting devices would be a mere trifle as compared with the loss of time of the higher paid labor of the operatives in keeping it in order, or the loss in efficiency of the same operatives due to neglect to maintain the system at its proper efficiency. An adequate and scientifically devised lighting system, carefully maintained by the regular attendance of persons especially charged with its care, is a duty which every factory manager owes to himself, to his workmen, and to his stockholders or partners.

The Relation of Illuminating Engineering to Electrical Engineering

Some sagacious speaker at the Convention of the Illuminating Engineering Society defined an illuminating engineer as "an electrical engineer having horse sense." Like many another epigram, this phrase is more terse than perspicuous. It is well known at present that illuminating engineers are comparatively rare; did the speaker intend us to draw the logical conclusion from this fact? Or, if he intended the statement as a classification of electrical engineers, to what branch of the profession do those belong that have not "horse sense?" In one respect, however, the meaning is unequivocal: all illuminating engineers have "horse sense." But there again we are confronted with a peculiar adjective; what kind of sense is horse sense? Perhaps it is a modern synonym for the older expression, "common sense," chosen for the reason that common sense so-called, being admittedly uncommon, the term is self-contradictory; it is perhaps easier to comprehend the meaning than to paraphrase the word as thus used. There is undoubtedly a certain quality of mind which has the faculty of looking over, or through, the unimportant details and intermediate steps, and coming at a final conclusion by instinct; and this factulty of reaching correct conclusions at first hand, regardless of all sophistries and illusions, is indeed of inestimable value.

But, leaving aside this question of etymology, the statement that an illuminating engineer is a kind of electrical engineer will, like the rat hole which Lincoln discovered in a client's office, "bear looking into." Must an illuminating engineer be first an electrical engineer? Or must he be an il-

luminating engineer first, and an electrical engineer last; or need he be an electrical engineer at all, and if so, to what extent? Beyond doubt the larger part of illuminating engineering has to do with the use of electric light. This does not necessarily mean that the electric light gives a better illumination than other illuminants, but that the more numerous forms of electric lamps, and the more elaborate structures in which they are used, render the problems of their use more complicated. It is impossible to draw a sharp defining line between the collateral branches of Science, and this pertains to illuminating engineering as well as to other specific phases of engineering science. The illuminating engineer should have a considerable knowledge of certain branches of electrical engineering. Thus, in the case of exterior lighting, he should have some familiarity with the various systems of transmission, and the relative efficiencies, with reference to the generation and distribution of the current, of the various forms of electric lamps. In interior lighting he should be sufficiently familiar with the principles of wiring to determine which of two or more arrangements of light-sources will require the least expensive and most practical wiring installation. He should furthermore be able to determine approximately the difference in cost of different wiring specifications. Many installations—could we not say most?—have either too many or too few outlets. On account of the inate frailty of human nature, there are cases in which architects, whose commission depends upon the total cost of construction, or the electrical contractor, whose profits depend upon the same thing, will specify a super-abundance of outlets for light-sources, and points for switches. On the other hand, the owner, actuated by another phase of this same human frailty, will often cut down the outlets and switch-points to such an extent as to make an adequate lighting installation a practical impossibility. To find a happy mean between these extremes is where the "horse sense" of the illuminating engineer comes in. On the whole, it is far better to err on the side of too many than too few outlets and switch-points. The entire cost of the wiring is relatively small compared with the total cost of a building; and it is always a simple matter to leave a lamp out of commission, or to cover up an outlet entirely if not required; but to install an outlet or switch-point where none was provided originally is an awkward and expensive operation. Cases are almost without number in which this patching up of originally inadequate wiring has to be resorted to; in fact, one can scarcely go into an office building, store, or factory, in which such make-shifts are not at once in evidence. We have seen million-dollar office buildings in which outlets on moldings had to be provided before the offices could be used. Besides defacing the building, and being expensive, such wiring is often contrary to the accepted code, inasmuch as outlets are thus required to supply a number of lamps, which were originally intended for only one or two.

Besides providing a sufficient supply of outlets for such light-units as may be required for the immediate purpose, but also to afford means of adding others, or for changing their position to meet future requirements, a liberal supply of switch-points should also be provided. The use of a so-called "pendant switch" is a declaration that the electrical engineer neglected to provide a wall switch in its proper place. Like many cases of drop lights, it is a make-shift for what should have been a permanent fixture.

The fact that an electric light can be turned off and on at any distance has perhaps contributed more to its adoption in this country, especially in dwellings, than any other single feature, and this convenience should be taken advantage of to the limit. Here again "horse sense" is a great virtue in an engineer. There are no mathematical rules for determining where switches should be placed; that they should be placed at the most convenient points and whenever and wherever they will add to the utility and convenience of the user, is the sole rule for guidance. We have known of a very efficient illuminating system being condemned because of faulty arrangement of the switch-points, which had been overlooked by the illuminating engineer.

If the client is inclined to object to the additional expense, there are two lines of arguments that can be brought to bear: first, the additional expense has to be borne but once, while the convenience lasts as long as the building; and second, that ways can frequently be found for trimming the purely ornamental—or alleged ornamental—features of the installation if necessary, in order to offset the additional expense of sufficient outlets and switch-points.

The Second Annual Meeting of the American Gas Institute

As announced in our previous issue, the American Gas Institute held its second annual meeting at the New Willard Hotel, Washington, D. C., on October 16, 17 and 18. Judging by the evidences visible to an outsider, the meeting was a decided success. The number in attendance was a goodly majority of the total membership, and the general enthusiasm and interest in the proceeding was decidedly marked. The various papers presented touched many of the important phases of the manufacture and sale of gas, and the reports of the committee on the several important matters under their consideration must afford a valuable addition to the technology of the industry.

The Institute may be considered as a counterpart in the gas industry of the National Electric Light Association in the electrical industry; for while the latter particularly specifies light in its title, this merely bears evidence of the fact that the electrical industry was originally devoted entirely to the production of light, and that the generation and supply of electric current for power and other purposes is a development that has taken place since the foundation of the Association. In noting the program of papers and reports, illuminating engineers will be disappointed at finding no subjects specifically pertaining to their profession; but in this respect the Institute, which is only celebrating its second anniversary, is but a year behind the N. E. L. A., the latter association having first recognized this branch of engineering at its Convention held last June. The proceedings of the Institute, however, were not without interest to illuminating engineers. A very carefully drawn and elaborate report on "Methods of Taking Candle-power of Gas" was presented by Mr. W. H. Gartley, Chairman of the Committee appointed to investigate the subject. An abstract of this report will be found elsewhere in this issue.

The American Gas Institute unquestionably has a wide field of usefulness, and the opportunity for a long and useful career before it. The gas interests have not been wanting in various kinds of associations, but heretofore these have generally been of a more or less local character. The In-

stitute, being national in its scope, should prove as valuable a factor in promoting the interests of the gas industries as the N. E. L. A. has been in promoting the electrical industries; and that is no small item. In this connection the National Commercial Gas Association may also be mentioned. This latter is, we believe, less than a year the senior of the Institute, and has proven itself of practical value.

Of the desirability of maintaining two distinct national organizations it is perhaps incompetent for us to speak; but a cursory view of the situation would give the impression that the truism, "In union there is strength," might apply in this case. With the unusually aggressive methods and policies which have maintained in the electrical industries, especially within the past two years, there is need for the gas interests to combine and strengthen their forces in every way possible, in order to hold their due "balance of power." The panic that seized upon the holders of gas company shares on the announcement of the successful advent of the electric light was soon proven to be unfounded. The invention of the incandescent gas mantle, the increasing use of gas for fuel, and the inertia of custom have been sufficient to not only sustain the gas industry, but to afford it a field for advancement. But there is not one of these directions in which the electrical interests are not pushing with might and main. In the field of lighting they have at their command the powerful advantage of greater convenience, less heat, and greater artistic possibilities; while the gas has continued to maintain its advantage of cheapness and equally good quality of illuminating results. As we pointed out in our last issue, the electrical interests have given far greater attention to the descriptive and artistic side of illumination than have the gas interests. In their eagerness to occupy the rapidly expanding field of heating, the gas interests have neglected their opportunities in keeping abreast of progress on the artistic side of lighting. Some of our good friends were inclined to take issue with our statement that gas is being driven to the wall as a luminant by the electric light, and that unless the gas interests awaken to the necessity of keeping up with the procession in the general improvements in lighting, gas lighting must decline as a system of illumination. It is not sound ethics for a physician to belittle or hide the symptoms of disease to his patients, and it is equally bad ethics for a technical journal to present only the virtues of its clients. The facts should be given, even though they may have a disagreeable taste. We believe no one will seriously dispute the fact that in this country gas lighting has been forced into a secondary position by the electric light in practically all cases in which elegance and appearance are important considerations. At first the electric light was introduced as a novelty; then it was used in combination with gas; later gas burners were placed here and there as a mere resource in case of emergency; and at the present time there are plenty of large buildings erected in which even this infrequent use of gas is not provided for. Comparatively little has been done in the improvement of gas fixtures, and consumers have been left pretty much to their own devices as to how they make and use the light. While heat, and perhaps power, afford the largest fields for expansion in the gas industries, the lighting field is still too important to be neglected. What is wanting in this regard is more attention to the design and construction of gas fixtures; a better system of in-

spection and maintenance; and more systematic and intelligent efforts to keep the public posted on the improvements and advantages of gas lighting.

The theory that the public *must* buy gas, and that improved burners and apparatus reduce the amount of gas consumed, and hence the revenue of the company, has been exploded by the policy of the more aggressive electric companies. Good light, good illumination, and good service are the foundations of present success and future dividends wherever the sale of luminants is concerned; and wherever there is open competition the company making the most systematic and intelligent use of these principles will lead, whether it be furnishing gas or electricity.

Meter Reading in the Public Schools.

The accusation is frequently brought against the common school system that the studies prescribed are not practical. While the practicability of knowledge is not the only criterion by which to judge its educational value, the purely utilitarian side must not be neglected. Progress in science and the arts is continually changing the nature of practical knowledge, so that what was of every-day use a generation ago may be quite useless at the present time, and what was unheard of at that time may now be of general importance. The use of gas and electricity for household purposes has become almost universal, even in towns of a thousand or less population, and is continually increasing. The money paid annually amounts to many millions of dollars; and yet it is probable that not one bill out of one thousand is ever intelligently checked up by the person paying it. To the average householder the meter is a sealed book in more senses than one.

The reading of a gas or electric meter is a very simple problem, and should be regularly taught in every public school. If a small portion of the time that is frequently expended in attempting to teach pupils the numerous denominations of the metric system, which are never used in practice, were devoted to the study of reading gas and electric meters, much more valuable information would be acquired. No one would be more benefited by such instruction than the companies furnishing gas and electricity. It would avoid many of the misunderstandings which lead to ill-feeling on the part of the public, and correct some abuses which may creep in, in spite of the best efforts of the management of the companies. The management of gas and electric companies, as well as illuminating engineers, should, therefore, make an effort to have regular school instructions given in meter reading. The companies might well afford to furnish printed lesson leaves for this purpose.

The Outlook for Prosperity in the Lighting Industries

In view of the general lull in business produced by the financial panic from which the country is just beginning to recover, the question as to the outlook for business in the near future is of the greatest interest, and any information tending to throw light on the subject must be welcome. We print elsewhere in this issue a special communication on this subject from Mr. G. W. Pearce, whose connection with the Financial Department of the *New York Sun,* as well as his wide experience, and recent special commission to investigate this subject, must give his words unusual weight.

Correspondence

Editor THE ILLUMINATING ENGINEER:

Dear Sir:

About twelve years ago the writer was assigned to duty as Superintendent of the State, War and Navy Department, in Washington, where there is a large electric lighting plant as well as about 6,000 gas jets. The building was originally designed to be lighted by gas; the installation of the electric plant was subsequent.

The gas company has a monopoly, but Congress has placed certain restrictions on the price and quality of the gas which leaves the company a fair living profit.

As soon as electric lighting began to show fair economy, and bid fair to become a formidable rival of gas, there began to be improvement in the gas burners.

The writer was obliged to give consideration to the goods of any bidder, and to accept the lowest bid for any article, *cetaris parabus*.

No one can tell, by mere inspection, the merits of an electric lamp, nor of a gas burner; nor is it good business to take the word of any or all salesmen, as to the merits of the goods they are selling?

The writer, therefore, provided a photometer and also a good test gas meter; it is a Heilne and McIlhenny meter. A number of new gas burners were offered in competition, a number of which so closely resembled the Welsbach that the writer could not tell the difference.

The tests were all made by the writer, with the assistance of Mr. Cornwall (since deceased) in the basement of the State, War and Navy Department Building.

We found a great many places, in that granite building, where light was not often needed, and where it would have cost considerable to run wires, and in such places we continued to use the gas; it therefore became important to ascertain which was the most economical burner for us to use.

We tested every incandescent electric lamp and every gas burner submitted to us, until enterprising salesmen began sending us lamps and burners through the mail, with a letter inclosing a return envelope, self-addressed and stamped, when we became conscious that we were being used to aid in the development of some enterprise. At this point we replied to such letters once; after the second essay we returned some life insurance printed matter, kindly furnished by a nearby agent, and this usually terminated the correspondence.

The test of burners seems to the writer to possess value, and though made for the Government, they have served their purpose and the public is, in our opinion, entitled to them.

It may not be out of place, in a publication of this kind, to invite attention to the improvement in illumination

RELATIVE EFFICIENCIES OF DIFFERENT GAS BURNERS.

Name of burner.	Description.	Pressure in inches of water.	Feet of gas per hour.	Candle-Power.	C.P. per cu. ft. per hour.
International-incandescent	Incandescent, similar to Welsbach	1	3	28	9.3
Welsbach	Incandescent	1	2	29	14.5
Richardson	Incandescent, similar to Welsbach	1.1	2.2	32	14.5
Richardson	Lava tip: Fish-tail	1	4	17.5	4.3
Ballard		1	6.3	23.3	3.6
Ballard	Brass tip: Pin-hole flame 4″ high	1.1	1.35	0.8	.5
Ballard	Lava tip: Fish-tail	1	5.3	22.4	4.2
Ballard	Iron tip: Fish-tail	1	5	18.8	3.7
Ballard	Brass tip: Fish-tail	1	5.2	16	3.09
Bacon Co.	Two jets and one cock: Fish-tail	1	8	16	2
Bacon Co.	Lava tip: 2 pin-holes	1.1	5	21.1	4.2
Acme		1.1	1.7	12	7.05
Matchless		1	4.2	17.6	4.1
Matchless	Turned down to its stop	..	1.20	....	....
Matchless	Two pin-holes in brass tip	1.05	5.5	20.3	3.6
Argand		1	4.1	16.8	4.09
Bray		1	4	12.1	3.02

which has taken place in the lifetime of the writer. When a small boy, living in the sparsely settled part of the city of Washington, where no gas mains had been laid, it was the custom to light dwellings in the neighborhood with oil lamps. At that time the New Bedford whaling fleet was returning, annually, with good fares of sperm oil, but very soon the whales became decimated and menhaden oil was substituted, and the supply was assisted by candles. We were then accustomed to but a small quantity of artificial light and we were satisfied with it.

Someone on Long Island discovered that a good illuminant could be distilled from cannel coal; that coal was imported from England. The distilled oil was called kerosene, and we were glad to get it at $1.15 a gallon; its superiority over fish oil was immense.

Later on, the inhabitants in the region of Oil Creek, in Pennsylvania, were collecting an oil from the surface of a creek, called Oil Creek, and selling it for a medicine; it resembled the kerosene. An enterprising native conceived the idea of boring the ground adjacent to the creek, believing he might get the oil in bulk. His efforts were crowned with success. Others bored; rivalry ripened into criminal opposition, among the borers, and fights and assassinations were common. At that time a young man named Rockefeller appeared, and brought order out of chaos, by uniting the borers into a stock company. He then began the refinement of the oil, and in a short time was able to put kerosene on the market at 8 cents a gallon. Then there were by-products which he has been able to utilize and turn to good purposes. A great poet, or rather a great philosopher, said "the good a man does is oft interred with him." Let us look at the good this man has done, and give him some credit before he dies, for he is now an old man. It is by no means uncommon to hear contemptuour reference made to Mr. Rockefeller

on the stage, in almost any theater in our large cities. The public seems to have him "on the run" and one of the favorite gags is that "he goes to church on Sunday."

Though no one can be justified in violating any law of the land, yet we should not lose sight of the good this man has done in the past, nor the good he is doing in the present.

What was a virtue a year ago seems to be a crime now. All merchants will sell at wholesale cheaper than at retail. Then why should not railroads carry tons of freight at less per pound than they would carry the same number of pounds? These things have been going on so long that they have had the sanction of the people, and have become a custom. We do not think it can ever be justifiable to violate a law, no matter if the law entirely upsets custom, as this rebate law has done, but it will be right to look on both sides of the life of the accused.

G. W. Baird,
[Read Admiral, U. S. A.]
Washington, D. C., Oct. 27, 1907.

Illuminating Engineering Publishing Co.,
12 West 40th St., N. Y.
Gentlemen:

I was very much interested in the article on "Relative Cost of Light from Different Sources," which appears on page 623 of your October issue, but I think that you will agree with me that there are several discrepancies in same.

I would call your attention to the following mistakes:

First: The word "cents" is omitted after 2.2 on the next to the last line, page 623.

Second: In the second line on page 624, the word "six" should be "sixty."

Third: In the next to the last line in the paragraph on High Pressure Gas Lamps, instead of 45c., the figure would be .45c.

Fourth: In the ninth line of the paragraph on Nernst lamps, the word "six" should be changed to .6; the bracket reading "Six-tenths cents per kw. hr.").

In giving this article to my solicitors, I have made the above corrections which I think are according to the ideas which Mr. Irwin intended to convey and I call your attention to the matter as I feel sure that you do not wish any discrepancies to creep into your publication.

Yours very truly,
Wm. Rawson Collier,
Contract Agent.
Atlanta, Ga., Oct. 18, 1907.

CASHIER BOOKKEEPER CONTRACTS ADVERTISING

Commercial Engineering of Illumination

The Outlook for Prosperity in the Lighting Industries

By George Wilfred Pearce, C. E.

(Financial Editor, New York Sun.)

The statements which follow with relation to general condition of the lighting industry in the central west, and parts of the southwest and northwest, embody the opinions of upward of four hundred gentlemen of the first prominence as executive officers of great gas light and electric light corporations. These opinions were gathered in interviews with these gentlemen during a tour of those sections made by the writer as financial editor for the largest organization of capitalists in this country, whose aggregate holdings in industrial stocks are in excess of six billion dollars.

Among the heads of great illuminating engineering enterprizes seen by the present writer within a few hours before this issue of The Illuminating Engineer went to press, was President Samuel Insull, of the Commonwealth-Edison Company, Chicago. This great corporation is putting forth electrical energy that is the equivalent of 1,750,000 16 c. p. lamps. President Insull said that his company's business in October established a new high record, and that trade conditions warrant the belief that the ratio of increase in the majority of central stations throughout the west will doubtless be maintained; and that so far as can be determined by a study of present conditions, the recession in trade that affects a few channels will not produce an appreciable effect upon central stations in important commercial centers. Gentlemen like President Insull possess exceptionally good opportunities for learning the exact condition of affairs in many industries. Their assistants are constantly pushing for business in every channel of trade. Consequently, the solicitors keep their superior officers fully informed of the state of the business tide. These officers report higher up, and then all that has been gathered in the way of important information as to commercial conditions is laid before the President. In the darkest hour of the most panicky day in the stock markets during last week, it was the present writer's privilege to hear from the lips of President Insull, a most graphic and cogently reasoned account of the exact conditions governing the great industries that center in the Chicago dis-

trict. This information was telephoned throughout the country, and had a most gratifying effect upon the markets for several forms of industrial stocks predicated upon illuminating engineering plants.

Illuminating engineers have won deserved distinction among great financiers during the crisis which is passing away, by reason of the good work which they did in allaying popular misapprehensions regarding banks, saving and deposit, and trust companies, upon which was made, under the direction of the most powerful bear syndicate the world has ever known, an all-along-the-line assault upon many forms of investments. These assaults were in the west made in large part by men who for years have been venomously fighting the forward policies of the greater gas and electric lighting plants. The ablest combatants with tongue and pen against those enemies of these great industries are found among our illuminating engineers. Many of these men are the mental superiors of the best minds employed by the conductors of the sensational newspapers which are in large part responsible for the nefarious work that has intimidated capital in a number of industries. Throughout the west illuminating engineers are rated high for public spirit, and for work in promoting sound doctrines in civics. Their weight is put forth for righteousness, and they are to be regarded as much more than mere units of population employed in the lighting industries.

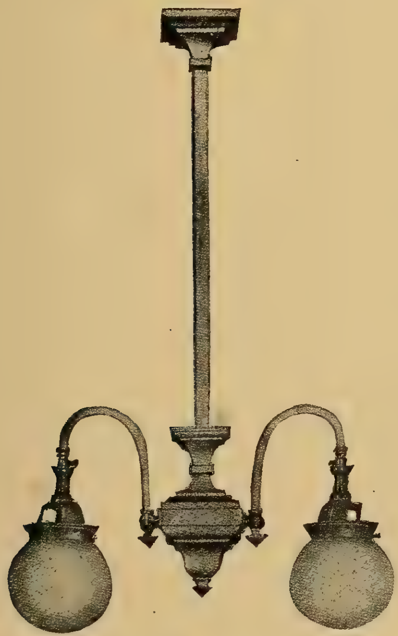
Carefully tabulated reports from architects and constructional engineers in all cities of the west and southwest of upward of 50,000 inhabitants, show that contracts to go forward, regardless of tight money markets, amount to $234,000,000. For new enterprises in railroads, hydro-electric power plants, and kindred undertakings calling for enormous sums of money that would yield only far off returns to investors, business is dull; but for illuminating engineering work in towns and cities business is very good, and is destined to improve within a few weeks. The recession in the price of copper has had a stimulating effect in electrical engineering, and lower prices for gas pipes and fittings is benefitting gas engineering.

At one time during this trip in the west to investigate business conditions, I had 156 of the best interviewers in the country employed in making reports. All who reported on the electtrical and gas lighting supply lines said that stocks are small in the hands of manufacturers and distributors. The west and southwest are very rich. The only trouble is that in those parts of the country the enormous sums that have recently been expended in enlarging old plants and building new ones have made thousands of concerns short of ready money. Of course these vast expenditures have actually added to the wealth of the nation. Bumper crops and enormous outputs from mines in the west and southwest are already rolling a golden stream in the form of payments therefore from the east and from Europe. In the matter of cereals alone, the chief statistician of the Board of Trade in Chicago states, that if the tonnages that will pass through that great city on account of the crops of 1907 were piled on a site fifty miles square it would attain the uniform height of fifty-six feet.

New Publications

Reflex Inverted Gas Lamps and Fixtures.—A catalogue, 36 pages and cover; Welsbach Company, Gloucester, N. J.

The construction of their inverted burner, now well known by the trade name "Reflex," is clearly described. The comparative distributions of light with different forms of shades and globes, both of the inverted and upright types of burner, are given, and a number of fixtures, including side brackets and pendants, are illustrated. Particularly worthy of mention are the designs of pendant fixtures, which are plain, but treated very artistically. We reproduce a single example. This fixture, especially when made with four arms, is particularly pleasing, due largely to the use of square tubing and canopy, which the illustration does not adequately show. It is listed at $16.00 for the two-light, and $24.00 for the four-light fixture.



Bank and Office Lighting by Electricity.—A Booklet, 16 pages; Nernst Lamp Company, Pittsburg. Illustrations are given of a number of representative installations of the Nernst lamp in banking houses and offices, including the following representative firms: Sears, Roebuck & Co., Swift & Co., and American Correspondence School, Chicago; Larkin Company, Buffalo; Colonial Trust Co., Pittsburg, and First National Bank, El Paso, Texas. Also shows several fixtures specially designed for use with the Nernst lamp. One, of a particularly neat design, is reproduced below.

Lux.—Volume 2, 1907, 24 pages and cover; Nernst Lamp Company, Pittsburg.

This is a bound volume of the dainty little monthly publication devoted to the interests of the Nernst lamp. Contains illustrations of typical installations, interspersed with various entertaining and instructive bits of information.

Supplementary Bulletin of Wireless Clusters and Lighting Specialties. — An 8-page circular; Benjamin Electric Manufacturing Company, Chicago.

HOME COMFORT.—A Booklet on "Gas for Lighting," 24 pages and cover; The People's Gas Light and Coke Company, Chicago.

This neat little booklet is published for general distribution among householders using gas for lighting, and is intended to assist them in using it to the best advantage. The purposes of the book and the instructions given are so brief and admirably phrased that we quote at large from it:

Home Comfort illustrates and describes our line of mantle lights designed expressly for home use. Conditions and terms under which these lights are sold. How to select lights that are best adapted for the room to be lighted. Our plan to inspect lights for the purpose of placing new mantles. How to take advantage of our call service when lights are in need of repairs.

* * * *

Our inspector will call within a few days with sample lights for you to select from, or word to us will bring full information to your door.

OUR PROPOSITION.

We will furnish and place on your fixtures such mantle lights as you may select from those illustrated in this booklet. We will supply and put up any repair parts needed to place mantle lights in good order that you may now have on your premises. All mantle lights supplied and repairs furnished will be charged for at prices quoted in this booklet.

* * * * * *

Our inspector is authorized to collect for such lights and supplies when the same have been delivered and put up.

* * * * * *

We will inspect, clean, or repair any flat-flame burners free.

BE NOT DECEIVED.

Our business is to sell gas, therefore it is our desire that our customers get satisfactory gas service and appliances at a satisfactory cost; and for this reason we warn our customers against purchasing inferior gas appliances that may be presented to them from time to time.

Mantle lights are not always what they seem. There is no end to the cheap imitations now on the market. To test their respective values (or worthlessness) in efficiency and durability it takes time, money, technical training, and special apparatus. We have all of these, and have paid for our experience; but it need not cost you a cent.

The best is the cheapest; therefore we offer none but the best.

OUR GUARANTEE.

All mantle lights illustrated in this booklet have been fully tested and approved by us. You can select any of them with the assurance that they will give entire satisfaction.

We fully guarantee them in every respect.

IMPORTANT.

To insure the best results, globes, chimneys, or shades must be kept clean, and mantles renewed from time to time. Screens and interior of burners should be brushed occasionally to remove the dust drawn in by suction of the burner. We have a force of inspectors trained for this purpose, who will call monthly to keep lights in proper condition and renew mantles.

After the fixtures in your premises have been equipped with burners, mantles and chimneys, the Company will, upon the customer signing a request therefor, maintain gas burners and mantle lights. A small fee is asked for this service. (See table of rates on opposite page.)

All mantle lights in the premises must be included in the contract.

Charge will be made for the necessary material used to put lights in good condition before entering into this contract.

All renewals of mantles, standard chimneys, and gauzes to be made by this Company. No shades, globes, or other glassware will be renewed.

This Company will not replace at its cost any light, or part of same, due to loss by fire or carelessness on the part of the user, or stolen, or breakage caused by house-cleaning.

To clean glassware use warm water and soap. Dry with a clean cloth or tissue paper. If glassware is hot it should be allowed to cool before cleaning.

When removing glassware for the purpose of cleaning, care should be used. Do NOT allow the glassware TO TOUCH the mantle.

Turn on gas full when lighting, then turn down until light suddenly brightens.

If lights do not work properly, notify our north branch, 653 North Clark street, Telephone North 34.

INSPECTION AND RENEWAL RATES PER MONTH.

5 Mantle	Lights	(Minimum	Rate)	..$	.50
6 "	"	"	"	..	.60
7 "	"	"	"	..	.70
8 "	"	"	"	..	.80
9 "	"	"	"	..	.90
10 "	"	"	"	..	1.00

* * * *

More than ten mantle lights, each.... .08

The policy thus outlined is exactly in accord with opinions previously expressed in THE ILLUMINATING ENGINEER, as to what should be done in the way of maintaining the prestige of gas lighting by a broad-minded and progressive policy on the part of gas companies toward their patrons; and while this first pamphlet is intended only for distribution among the patrons of this particular company, we commend it to the careful consideration of the soliciting department of every gas company in the country.

Dignity in Advertising

The ultimate test of the value of all forms of advertising is, of course, the amount of trade which accrues to the advertiser; and the problem of how to direct advertising so as to bring maximum results is as complicated and difficult of exact analysis as is the art of writing literature that will attract the public sufficiently to win both their approval and their sheckles. Literature is universally taught in the schools and colleges, and there has recently been a School of Journalism endowed in one of the leading Universities; but for all this many of the most successful books have transgressed nearly all the tenets of the schools, and are likely to continue so to do.

Serious attempts have been made to reduce advertising to a sufficiently exact science to enable it to be taught by school courses, and there are a number of institutions offering regular courses of instruction. Without any disparagement of their honest and doubtless helpful efforts, we venture to say that the most successful advertising is still likely to emanate from those uninstructed geniuses who seem to have been especially provided by an all-wise Providence for this particular work.

Printed advertisements are a form of literature, and their value is determined by substantially the same laws and conditions that maintain in the case of purely literary works. In the old days, when farmers packed their butter in tubs or ferkins and took it to their local dealer for sale, the dealer had a very simple and clever way of sampling the contents from top to bottom of the package. He had a long, slender, fluted knife, which he could thrust through a hole bored in the top or bottom, and by giving it a half turn, could draw it out filled with butter from the whole depth of the package, which he could taste at any point he pleased—if he had the courage. A similar test is a very good one to apply to a literary production, namely; open the pages at random at various points, and start to read any paragraph the eye may light on; if interest is aroused wherever tasted, it will be safe to turn to the beginning and read the book entirely through. The same rule applies to advertising literature, only with greater effect. Every paragraph and every sentence should be sufficiently attractive to hold the reader's attention.

Advertising literature belongs to a class which is usually considered the most difficult to produce, that is, the didactic, or essay class. Works of fiction may be successful on account of the interest in the story, although told in a clumsy manner, but advertisements cannot, generally speaking, make any use of this element of interest. The difficulty of producing didac-

tic matter that will attract and hold attention, as compared to mere story-telling, is sufficiently evidenced in the enormous quantity of novels that are annually produced, compared to the amount of serious books.

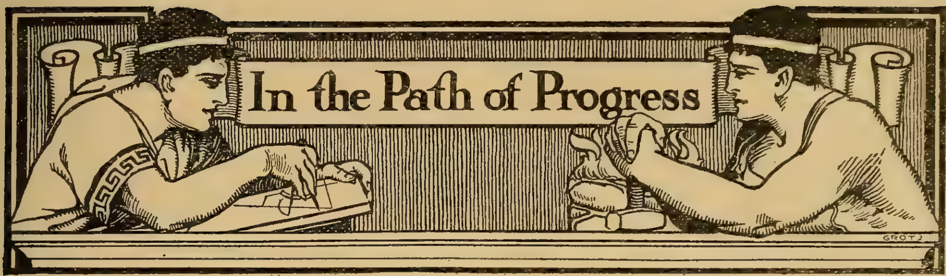
The writing of good advertising matter is, therefore, not a simple or easy task. The points that make for success in serious literature must hold in the case of advertising matter. The first of these is sincerity. Some years ago an author thought to make a "hit" by boldly stating in his preface that "while others might writer for glory, he wrote writing for lucre." Both the intended joke and the book fell flat, as was to be expected. The advertisement that does not impress the reader with the fact that the advertiser is absolutely sincere in his statements, even though he may be prejudiced or mistaken, is a perfectly useless piece of work. If you do not believe what you are saying, you certainly cannot expect anyone else to believe you. Mere extravagant claims, like "best in the world," and wholly unsubstantiated arguments as to superiority, breed scepticism and doubt, rather than faith. The essays and other didactic works that have lived through the centuries have stated plain truths which had already been known, but never so well expressed. What is more satisfying or attractive than to find your own indistinct and nebulous thoughts expressed for you in clear and shining words? Flashy witticisms, cheap jokes, and a style that can only be adequately described by the slang expression, "smart Alec," will never make any lasting impression upon the hearer or reader.

There is quite a general tendency at present to embody such principles in advertising literature, which both in matter and manner becomes thus a case of "sounding brass and tinkling cymbals." Such brassy tinkling may catch the ear of the office boy, but is ill suited to the purpose of keeping the purchasing agent thinking after it has been consigned to its resting place in the waste-basket. Purchasing articles and paying out good money is no joke, and is rarely done under the spell of even the most boisterous stories.

Furnishing light and illumination is a distinctly dignified business. Light has always been the symbol of knowledge and progress, and its use always tends to the betterment of existing conditions. The solicitor is as far as possible removed from the trickster or curbstone vendor. He is, or should be, an advance agent of progress. He should not only know his subject thoroughly, but believe in it,—believe in the dignity of his calling, and in his own sincerity of purpose. Let the quack medicine promotors and the yellow literature producers have complete monopoly of cheap and flashy methods of advertising. Stick to the facts; nothing is so attractive as facts, when they represent what is inherently good. It is only the inferior, the imitation, the unworthy that needs concealing, or bolstering up with misleading and extravagant claims.

In conclusion we can do no better than to quote a paragraph from the advertising matter of that signally successful concern, the National Cash Register Co.:

"People who have accomplished work worth while have had a very high sense of the way to do things. They have not been content with mediocrity; they have not confined themselves to the beaten tracks; they have never been satisfied to do things just as others do them, but always a little better. They always pushed things that came to their hands a little higher up—a little farther on."



Introductory

The position of THE ILLUMINATING ENGINEER toward what is familiarly known as the commercial "write-up," has been consistently maintained, both in precept and practice. Its policy in this regard has included two main principles, viz.: first, that the "write-up" containing only the claims set forth by the interested party does neither the reader nor the manufacturer justice; and second, that the progressive manufacturer is entitled to full credit for all improvements which he may bring out in his particular field, entirely irrespective of any advertising patronage, past, present, or prospective.,

The purpose of establishing this department is to furnish such information. It is essentially a news column, and will be conducted somewhat on the lines of the Review Department of literary periodicals. Books are the commercial product of the author and publisher, just as new apparatus and machinery is the commercial product of the inventor and manufacturer. The ordinary trade "write-up" is, therefore, the counterpart of what a book review, written by its author or publisher, would be. It is, of course, entirely fair that the inventor or manufacturer should be heard in regard to the merits of their productions; but the claims of the producers will be clearly distinguished from our own comments.

We cordially invite all inventors and manufacturers in the field of lighting apparatus and supplies to advise us of all improvements as soon as they are ready to have the knowledge of same made public.

A Word to Advertisers

It is the policy of THE ILLUMINATING ENGINEER to accept advertisements only of such articles or services as have a bearing upon the subject of illumination. This policy is the only one that is entirely fair to both advertiser and reader: to the advertiser because he does not lose his identity in a miscellaneous collection of advertisements entirely foreign to the legitimate field of the magazne; and to the reader, because he will not have to look over a collection of advertisements in which he has no interest, in order to select those which he may wish to investigate.

It is safe to assume that every reader of THE ILLUMINATING ENGINEER is in some manner interested in the subject of lighting, and the manufacture of lighting apparatus or supplies, or the professional practitioner who has services to offer, is consequently assured that every copy in which his advertisement appears goes into the hands of possible purchasers of his wares.

Periodical advertising is like the parable of the sower: "The seed that fell by the wayside," and in "stony

places," is the advertisement that is lost sight of in the multitude of appeals which do not interest the reader; and the seed which "fell in fertile soil, and produced some ten-fold, and some an hundred-fold," is the advertisement that falls into the hands of the purchaser or user of the wares advertised.

In the absence of some positive reason to the contrary, the advertised article should be purchased. This assurance is not based on self-interest, but upon sound logic and facts. Omitting that comparatively small class of advertising of articles which are either evidently fraudulent, or at least of very questionable merit, such as quack medicines and "get-rich-quick" schemes, an advertised article must of necessity have merit, or at least be honestly believed to have merit by its manufacturer. Advertising is a permanent investment. It is not the first order which results from the advertisement that the merchant depends upon, but the subsequent orders which will come from the same purchaser, or the orders that will come from the purchaser's friends and associates. To advertise an inferior article would, therefore, be the most stupid of short-sighted business policies. Advertising in general is for the purpose of informing the public of the merits of various wares or services in the shortest possible time. It is true that an article of real merit will make its own way, *in time;* but this time may be so long as to exhaust the resources of the manufacturer, or the conditions most favorable for its sale —as for example, in the case of a patented article. In buying an advertised article, therefore, the purchaser has the positive assurance that he is receiving the results of the very best efforts of the producer, and in all probability a better product than that produced by non-advertisers, who are either imitators, or producers who are not willing to back their goods in an open appeal to the public.

A man who advertises has more than pecuniary gain in view; his reputation and honor are at stake; they must stand or fall by the merits of the article advertised.

An advertised article is met through a responsible personal introduction; an unadvertised article is a waif picked up by chance.

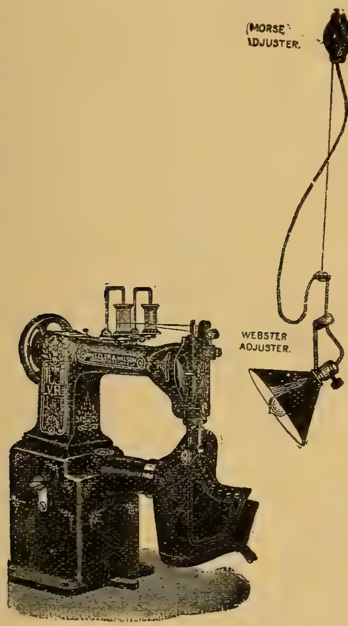
Some Handy Devices for Using Electric Light

The electric light owes its general adoption largely to the greater convenience and adaptability in its use, than that of any other luminant. It is not always the most conspicuous device that is the most useful. A considerable part of the secret of American success in manufacturing is in the constant effort to secure improvement in details. A second of time is not in itself of much importance, but a second saved once a minute, or even once an hour, by a sufficiently large number of workmen is a matter not to be neglected. It is in the many ingenious little devices for clipping seconds that the American manufacturer is pre-eminent. Numerous such little time-savers have been devised in the field of electric lighting, of which we can mention but a few in the present instance.

The ordinary drop-light, *i. e.*, a lamp suspended on the regular flexible wire, in almost all cases needs adjusting for height, in some cases only occasionally, in other cases frequently. This can always be done by knotting or looping the cord; but this method is clumsy, slow and injurious to the cord. A considerable number of little devices have been invented that are improvements on the crude method described, but

they all require the use of both hands and more or less time.

An adjuster which overcomes both of these difficulties is shown in the accompanying cut. It works on the familiar principle of the ordinary window shade roller, so that all that is necessary to adjust the height of the lamp is to pull it up and down, just as a curtain is raised or lowered, allowing it to stop wherever required. The convenience and saving in time effected where adjustments have to be fre-

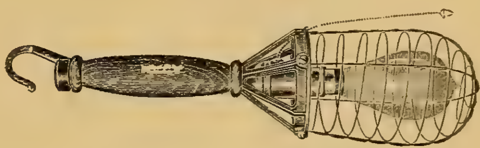


MORSE CORD ADJUSTER AND REFLECTOR TILTER.

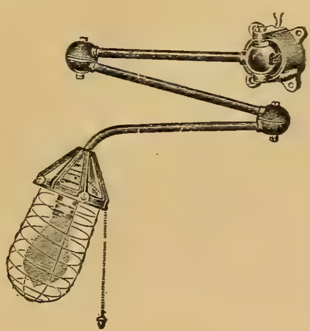
quently made, as for example, in use over machine tools where the lamp needs to be lifted out of the way when the work is to be changed, make it a very profitable investment. It sells for $6.00 per dozen for twisted cord, and $7.50 per dozen for cable cord; discounts from 25 per cent. to 40 per cent., according to quantities. Manufactured by Mr. Frank W. Morse, No. 514 Atlantic avenue, Boston, Mass.

Another clever scheme produced by the same manufacturer is a device for tilting the ordinary reflector shade at an angle; its construction is shown in the cut on page 665.

In many cases a combination of jointed and extensible arms furnish a support for a lamp that is far preferable to the use of a drop light or ordinary bracket. Such an arrangement permits a lamp to be fixed in any position within a considerable space, and can be moved by the use of one hand. Several styles of such a fixture, also manufactured by Mr. Morse, are shown on page 665. They vary in price from $1.75 to $3.00, with discounts varying from 12½ per cent. to 30 per cent., according to quantity.



An incandescent lamp attached to a sufficient length of flexible cord makes a portable light that is in every way preferable to a torch or candle. For such use the lamp should be provided with a suitable handle and protected by a substantial wire guard. A hook on the end of the handle for hanging up the lamp when convenient should also be provided. A device fulfilling all these requirements, made in an unusually substantial manner, is manufactured by The Wells Light Mfg. Co., 44 Washington street, New York, and sells for $4.00.



The same company also make a variety of wall brackets and ceiling pendants which utilize the ball and socket joint for the purpose of giving universal motion to the joints. A side bracket of this description is shown in the accompanying cut.

Gravity Feed Flaming Arc Lamps

Evolution in mechanics is always from the complex to the simple: the first conception of a machine is invariably more complex than the last. Improvements generally consist only in the removing of superfluous parts. The earliest form of arc lamp which automatically adjusted the carbons as they burned away, used a system of clock-work to accomplish this purpose; but this means was later entirely displaced, at least in this country, by the far simpler clutch mechanism, operated by a single series magnet, or both series and shunt coils, according to the conditions of the current supplied. The successful introduction of the flaming arc lamp has brought back the clock-work system of regulation. Since the flaming arc has unquestionably made a permanent place for itself in electric lighting, the desirability of avoiding the use of the more complicated regulating device has attracted the attention of inventors and designers. The arrangement of the carbons in a side-by-side position,—which, by the way, was the arrangement used by Jablachoff in the first form of arc lamp ever put to practical use in street lighting, has naturally suggested the possibility of providing a stop, or support, for one or both carbons to rest upon, so that, as they are consumed in operation, they will of their own weight feed down into position. With such a device it is only necessary to provide for a means of bringing the carbons together and separating them to strike the arc, which can be accomplished with a single series magnet. In its simplicity this device is ideal, and it is not surprising that several manufacturers have sufficiently satisfied themselves, at least, of its practicability to place lamps thus made upon the market.

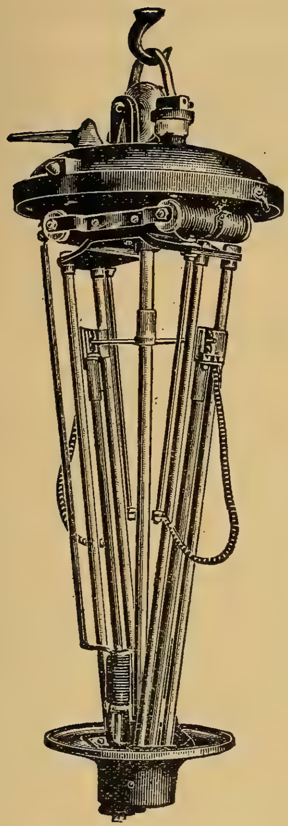
The first in this field was the Beck lamp. The feeding mechanism of this lamp is thus described by the manufacturers:

> One of the carbons, in D. C. Lamps (the positive), has a rib running its entire length. This ribbed carbon rests on an insulated metallic support K. This rib, resting on the support and through the action of the current, burns to a fine point, which point gradually disintegrates, allowing the carbon to sink slowly downward. Through a compensating chain attached to the other carbon, both carbons feed down at the same rate of speed. The feed is so gradual that the lamp burns quietly and without flickering. Should a jar or a defect in the carbons break this point suddenly, it takes only a few moments when a new point is formed. The arc is formed on the inner side of the carbons, and does not go near its point, therefore it is impossible for the support to be melted or damaged in any way. The rib remains comparatively cool, and as the carbon rests only on a small point on the support, the heat of the carbon does not communicate itself to any extent to the support.

The original Beck lamp was of German design, but the American form is manufactured by the Beck Flaming Arc Lamp Company, 58 West 15th street, New York.

The Helios Manufacturing Company, of Philadelphia, an old and well-known concern, has recently brought out a flaming arc lamp on the gravity feed principle, the mechanism of which is shown in the accompanying cut, and is described as follows in their catalogue:

> Secured to the top is a cast plate arranged to support the resistance spools and from which four rods converge, in two pairs, to a bottom casting. The two pairs of rods form the slides for the carbon holders as well as being the frame joining the upper and lower portions of lamp. Depending from the cast plate is the central



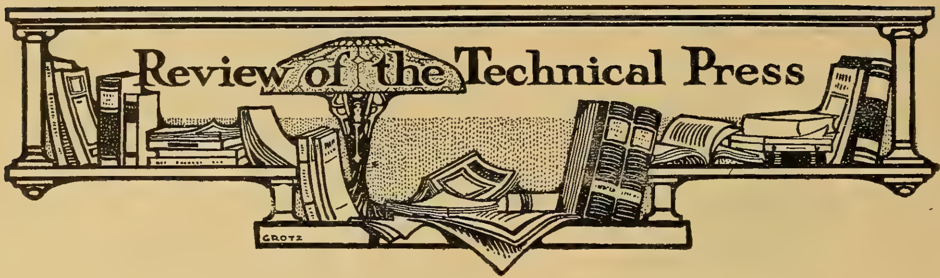
HELIOS FLAMING ARC.

tube on which a socket is arranged to slide freely, carrying two arms which engage the carbon holder supports. Attached to the bottom casting is a support with a copper stop, and one of the carbons rests on this stop at all times. The other carbon is then supported by the arms which engage both carbon holder supports, and in operation, as the resting carbon is consumed, the free carbon feeds downward along with the resting one, maintaining the arc in the exact same position. The bottom casting is recessed to receive a heat resisting plate which protects the upper part of lamp and also increases the life of the carbons. The blowing magnets are mounted on the bottom casting and the magnetic field is so disposed that the arc is maintained in its proper position relative to the cores of the carbons and the best illumination assured.

The cores of the magnets are connected by a brass strap which anchors the lower end of the central tube, preventing same from getting out of alignment. Above the central tube is a solenoid which operates a rod passing completely through the central tube, by means of a plunger and lever, the rod terminating in a device arranged to operate a pressure foot, the object of the pressure foot being to move the free carbon away from the resting one thus striking the arc.

The chief obstacle to the success of the gravity feed principle is the burning away of the stop upon which the carbon rests. In some cases copper is used, so as to offer as little resistance as possible and thus avoid "arcing," in other cases the use of a highly refractory, non-conducting substance is used. In a recent form of lamp a small clay pin is used, which is renewed at each trim. In all cases provision must be made for easy and cheap renewal of the stop. Although the principle of using a "stop," or gravity feed was tried and abandoned years ago, American manufacturers seem to have faith in the possibility of making it practical under present conditions.

Every new or improved piece of mechanism has to pass through two experimental stages: first, in the laboratory or workshop of the manufacturer; and second, in the hands of the ordinary user. The gravity feed lamp seems to have passed through the first stage successfully, and is just now beginning its second trial. Whether it is near enough "fool-proof" to withstand the abuse, as well as the use, which is the fate of all apparatus in the hands of the public, remains yet to be seen. Manufacturers, as well as users, will agree with us in hoping that it may pass the second experimental stage as successfully as it seems to have passed the first.



American Items

STREET LIGHTING IN THE CITY OF NEW YORK, by H. T. Owens, *Progressive Age,* October 15th. An illustrated, descriptive article, showing various types of public and private lamps and lamp-posts used for gas lighting in the streets of New York, with various items of cost connected therewith.

ON THE DETERMINATION OF MEAN HORIZONTAL INTENSITY OF INCANDESCENT LAMPS, by Edw. P. Hyde and F. E. Cady; *Bulletin of the Bureau of Standards,* Washington. This is a more detailed account of further investigations on this subject, the results of which were given in a previous Bulletin. The authors discuss a paper on the same subject recently published by Uppenborn in Munich, Germany.

THE USE AND ABUSE OF THE OIL LAMP, by "Engineer"; *American Gas Light Journal,* November 14th. Gives much practical information in regard to the care of such lamps, illustrating the directions by diagrams.

THE ELECTRIC ILLUMINATION AND WIRING OF THE SINGER BUILDING; *Electrical Age,* November. A detailed description of the electric wiring of this famous building; also shows the proposed method of outlining the tower with incandescent lamps. The subject of interior lighting is not discussed, except to state the number of lamps used on each floor.

SPECIAL STREET LIGHTING IN DENVER, *Electrical World,* November 2. Shows the proposed style of lamp-post to be used on Fifteenth street, which is to be made the show street of the town; also examples of billboard lighting.

ILLUMINATION OF BALTIMORE IN HOME WEEK, by Laurence Jones, *Electrical World,* November 2. A short description, without illustrations, of the display lighting on this occasion.

WINDOW LIGHTING, by Van Renssalear Lansingh, *American Gas Light Journal,* November 4th. Discusses the subject of window lighting with incandescent gas burners, giving curves distribution of various burners and accessories suited to the purpose.

EDITORIALS.

ELECTRICAL WORLD:

"The Lighting of a Large Retail Store." A review of Mr. Pearson's paper presented before the Chicago Section of the Illuminating Engineering Society.

"Comparisons of National Light Standards."

ELECTRICAL REVIEW:

"Candle-power Standards." Referring to the fluctuations in the light of the gas flame with different atmospheric conditions, the writer makes the startling suggestion that gas companies should be required to maintain a gas of a constant luminosity, irrespective of the weather.

Foreign Items

Compiled by J. S. Dow.

Processes for the manufacture of glow-lamp filaments from the rarer elements are daily increasing in number.

The *Electrotechnik und Maschinenbau* for October 6, reviews the recent patents on the subject, which include a modification of Kuzel's method of connecting the leading in conductors of a metallic lamp to the filament, and Parker's proposed method of constructing filaments by depositing a finely divided refractory, conducting substance on a fine non-conducting tube. In a recent number of the *Revue Electrique,* a patent of Siemens & Halske, dealing with the manufacture of tantalum filaments, is described. Tantalum filaments can be made by reducing tantalum to a finely-divided state, compressing the powder into a filament, and sintering together by the passage of an electric current. It is now proposed to utilize the bombardment of cathode rays for this purpose. Filaments so produced are said to be more uniform, and also, cheaper.

The number of the *Electrotechnik und Maschinenbau* referred to above, contains a review of the recent patents covering arc lamps. Gilbert, *Electrical Engineering,* Sept. 26, patents the simultaneous use of three or more pairs of inclined carbons in the flame arc. This is said to result in increasing burning powers and efficiency.

Mercury vapor lamps also receive detailed treatment in *Electrotechnik und Maschinenbau,* for Oct. 13. These patents deal mainly with improvements in starting devices for mercury lamps. One interesting device is that of Cooper-Hewitt (A. P. No. 843,534), in which the principle of a transformer, and the induction of an E. M. F. in the mercury vapor itself, are utilized to start the lamp. A new departure of the B. T. H. Co. (B. P., No. 13,413, 1906), is also described. In this lamp, the positive electrode is composed of the rarer refractory metals, wolfram, tantalum, etc., while the negative consists of metallic mercury. The lamp is started by bringing a spiral, composed of platinum, tantalum, or wolfram, and coated with rare oxides, etc., to a red heat. The gaseous contents of the tube then become ionized, and conduction begins.

An abstract of a recent paper by Dr. O. Bussmann, on the new quartz-glass mercury lamp, occurs in *Electrical Engineering,* Oct. 10, 1907. This lamp illustrates a new departure in the design of mercury lamps. Hitherto, workers on these lamps have used mercury vapor at a low pressure and small consumption of energy, it having been found that a certain definite pressure exists, for which the most efficient results, viz., about 0.6 watts per candle-power, were obtained. Under these conditions, only a small fall of P. D. per centimeter length of vapor was possible, and, therefore (as in the Cooper-Hewitt lamps), a long tube was required. If the pressure and consumption of energy in the lamp are carried higher than this point, the efficiency falls off, and is still deteriorating when the softening of the glass envelope into increasing temperature begins.

Bussmann, however, utilized a variety of quartz-glass, which could withstand a much higher temperature, and he then found that the "ineffici-

ency" of the lamp reached a maximum near 1 watt per candle-power, and began to improve again, until eventually a value near 1/5 of a watt per candle-power was reached.

Moreover, the spectrum of the light obtained under these conditions is said to be a great advance on that of the older lamps, and to contain a distinct red element. Quartz-glass allows ultra-violet energy to pass, and the great richness of the quartz-lamp in energy of this description renders it specially valuable for medical, photographic and other purposes. The severe action of an excess of these rays on the eyes and skin must, however, be very carefully guarded against, in lamps intended for general illuminating purposes. The tube (which, for a P. D. of 220 volts, is only about 15 centimeters long), is, therefore, enclosed in a globe composed of a variety of glass which completely suppresses these rays.

In this connection, a recent paper by Drs. Schanz and Stockhausen (*Zeitschrift für Beleuchtungswesen,* Oct. 10, 1907), is of interest. After pointing out that ordinary glass only partially absorbs these rays, Dr. Schanz recalls the fact that ultra-violet rays cause the lens of the eye to fluoresce, and that, in some cases a "cloudiness" is simultaneously produced. He suggests, therefore, that, in addition to other injurious effects, ultra-violet light may be influential in causing cataract troubles in the eye. Certainly, the injurious action of ultra-violet light ought to be carefully guarded against, especially now that such large quantities of it are available.

The same number of the *Zeitschrift für Beleuchtungswesen* contains a discussion by Dr. Stockhausen, of the safe brightness per unit area of radiating surface, of intense sources of light. He considers that any intrinsic brilliancy, of more than 0.75 H. K. per square centimeter, is objectionable from a hygienic point of view.

Without doubting the wisdom of this dictum, one would like to know the exact physiological experience by which the above figure was arrived at. The same question is discussed by J. C. Angus in an interesting paper recently reported in *The Journal of Gas-Lighting*. He suggests, as a criterion of safe brilliancy, that a light ought not to be bright enough to cause a perceptible contraction in the pupil-orifice, when brought into the field of view. Yet the reliability of such a test seems doubtful. So much depends on the history of the eye previous to its exposure to the source of light under consideration, and the condition of the eyes generally. Besides, it seems rash to assume that a light which causes the pupil-orifice to contract, is necessarily injurious. The estimate of 1½ to 2 c.p per square inch of radiatory surface, quoted by the author, is in fair agreement with that of Stockhausen, but somewhat lower than Dr. Louis Bell's rough estimate of 5 c.p. per square inch.

Mr. Angus also refers to the necessity for units of small c.p., and emphasizes the possibilities of gas lighting in this direction.

The long series of articles by Dr. Lux, on the efficiency of light production of artificial sources of light, was concluded in the *Zeitschrift für Beleuchtungswesen* for Sept. 30. The radiant efficiency, as determined by Dr. Lux, varies from 0.9 to 2.97% in the case of flame-sources, to about 18% in the case of the yellow-flame arcs. The actual efficiency, in terms of the energy given to the light source, is considerably less.

One interesting suggestion in this article is that the high efficiency glow-

lamp of the future will have a carbon filament. The author points out that the melting point of even the most refractory metals must limit the temperature of incandescence and, therefore, the attainable efficiency. It is, however, possible to increase the P. D. across a carbon filament lamp until 0.13 watts per c.p. is reached. It is true that, under these conditions, the filament rapidly deteriorates, but improved methods of manufacture may enable us to eventually produce a filament which does not do so. Such a filament must be absolutely homogeneous, so as to avoid the disintegration following the explosive expulsion of occluded gases. (Compare Strouds on tantalum filament, previous review.)

This view appears reasonable, when we remember that the rare metals, in the condition in which they are used in the manufacture of glow-lamp filaments, possess properties quite distinct from those attributed to them in their normal state. The valuable qualities of filaments composed of these rare metals, are probably due to the manner in which the metal of which they are composed is prepared, rather than to any inherent properties of the metal itself.

The continuation of St. Claire Deville's recent paper before the International Congress of Photometry at Zürich (*Journal of Gas-Lighting*), again merits attention. At the present time, when the question of replacing the candle-power standard of gas used with incandescent burners, by a calorific one, is being seriously considered, these figures should be of special interest. The author gives voluminous data on the illuminating power, calorific power, and flame temperature of different varieties of gas, mixtures of coal gas and water gas, and enriched gases. He points out the vagueness attached to the term "illuminating power" as applied to gas used with incandescent burners and distinguishes between the "customary" and "absolute" methods of defining illuminating power. On the whole, his results suggest that flame temperature has less influence on the light yielded by a burner than might have been expected, and that the calorific power and the illuminating power of a gas, employed for incandescent lighting, are closely related. The same journal abstracts another paper of no little interest, by M. Casaubon, on "Diffusive Phenomena in Flames."

The theory of the action of the inverted burner forms the subject of a very valuable address by Dr. Bunte. (*Deutsch. Verh. von Gas und Wasser, etc.*, see *Journal für Gas u. Wass.*, Oct. 5, 1907.) The author discusses the theory of the Bunsen flame, as applied to gas lighting, the alteration in its structure according to the proportions of air and gas supplied to the burner, and the exact conditions which determine the "lighting-back" of the flame. He further emphasizes the value of the ascending gases, in heating the gas before it reaches the burner, thus adding to the temperature of the flame and increasing the efficiency of combustion. Dr. Bunte is very sanguine as to the future of the inverted burner, which, he says, really marks a scientific advance in incandescent gas lighting, and is not, as some have supposed, merely an initiation of the hanging electric glow-lamp.

In this connection, we may note that Krüss (see review of technical press for previous month), came to the conclusion that, for a given consumption of gas, the M. S. C. P. of an inverted burner was less than that of a corresponding upright one, and he attributed this to the fact that much of the heat of the ascending gases is

spent in heating the burner and fixtures, rather than the mantle.

Drehschmidt, however (*Jour. f. Gas, Etc.*), objects that Krüss based his results on the performances of a single obsolete type of inverted burner. More modern types would give results twice as good, and so reverse the conclusion which Krüss' results suggest.

Krüss, in his reply, disclaims any attempt to deduce general results on the respective merits of different systems of lighting. He only wished to show that a mere measurement of the M. S. C. P. of each of the sources did not suffice.

The application of the inverted mantle to street lighting form the subject of a recent address by Winkler (*Jour. für Gas, etc.*, Oct. 5, 1907). He, too, discusses the theory of the inverted burner, pointing out that the initial heating of the gas, besides affecting the flame temperature, affects the composition of the air fed into it. The best proportions of gas and air in the case of a burner which has been heated up, are very different when the burner is in the cold state.

The author also deals with the distribution of light from the inverted lamp. For street lighting, an even illumination is wanted, and a maximum intensity in a vertically downward direction, is, therefore, undesirable. The diameter of the earlier mantles was sometimes comparable with their length, and, therefore, more light was thrown downwards. Now that it is possible to make the mantles longer, the maximum intensity usually occurs at an agle of 45° to the vertical. Uniform distribution is also promoted by suitably shaping the diffusing reflector above the burner, which, the author concludes, should be convex in the portions nearest to the mantles, and concave in those most remote.

The author next describes some different methods of raising and lowering lamps in the street. In some cases, this can be done without disconnecting the gas supply. Finally, he discusses the waste of gas by pilot-flames. In the case of upright flames, a pilot-flame commonly wastes 4% of the gas consumed by the burner when lighted, but the pilot-flame used with inverted lights consumes as much as 5½%.

It was formerly necessary to employ a pilot-flame for each of a cluster of burners in a single lamp, but a method has now been devised by means of which one flame can be utilized for the entire cluster.

Finally, reference may be made to an interesting experiment which was recently carried out at St. Gall, in Switzerland, in order to test the influence of pipes on the gas passing through them. The gas was allowed to flow through a pipe from Riet to St. Gall, measurements of illuminating and calorific power being carried out simultaneously at both places. Broadly, it was found that neither illuminating nor calorific power was very appreciably altered. The illuminating power appeared to be slightly decreased, but not much, while the calorific power was slightly greater. (*Jour. of Gas-Lighting*, Oct. 1, 1907.)

Among general papers on lighting and illumination, we may mention again that of J. C. Angus. (ref. cit.) Dr. Monasch has carried out an instructive set of experiments on daylight illumination. (*Jour für Gas Bel., etc.*, Sept. 21.) In his article he says, very truly, that our artificial illumination must be modeled on that obtainable from natural daylight. Yet little information on the strength of daylight illumination is available. The measurements of Dr. Monasch were made on the table, near the window of a room facing northeast. The

window was 2.5 by 3 meters in dimensions, and the direct rays of the sun did not reach the table, but only diffused light. Measurements were made at 12 o'clock noon, every day from February 1, to March 11, of the present year. The author gives a chart of these records of illumination, and details of the atmospheric conditions under which each result was obtained.

Few articles of great interest on the subject of photometry have appeared recently.

The *Journal für Gas Beleuchtung. etc.* (Sept. 21 and Oct. 13), publishes an account of the recent researches of Janet, Perot, Laporte and Jouast on the comparison of the Hefner, Carcel and Vernon-Harcourt standards of light. Finally, the two types of selenium and rubidium photometers mentioned by the author in the previous review, still remain to be described.

The nature of the selenium photometer, due to Presser (*E. T. Z.*, 28 p. 510, 1907. *Ann. der Elektrot., Sept.*, p. 469), will be understood from Fig. 1.

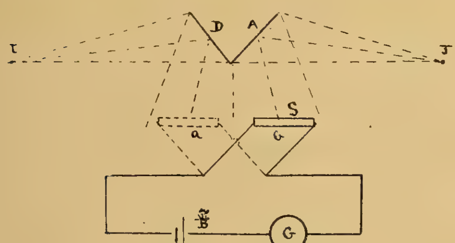


FIG. 1.

"A" and "D" are two mirrors illuminated by the two sources of light "J" and "I," so placed that the light is reflected perpendicularly. "S" is a selenium cell, which is driven to and fro between the positions "a" and "b," and is, therefore, in turn illuminated by the two light sources. If both lights are of equal intensity, the galvanometer, G, in series with the selenium cell, and the battery, B, shows a constant deflection; otherwise a fluctuating deflection is produced.

Practically it is found preferable not to oscillate the selenium cell, but to cause the light from the two sources to impinge upon it in turn, by utilizing a system of rotating mirrors.

One satisfactory feature of this photometer seems to be that any variation in the behavior of the selenium cell from day to day is eliminated.

The rubidium photometer of Elster and Geitel (*E. T. Z.*, Aug. 29, p. 864), depends upon the principle of Lenard, that the bright surface of an alkaline metal, in a rarefied atmosphere of hydrogen, sends out negative electrons, under the influence of light, which render the gas conducting.

A glass vessel, filled with hydrogen, at a pressure 0.33 mm. is used, and at the base of the vessel is placed a slice of rubidium, connected with one of the electrodes melted into the glass. In the upper half of the vessel is a similar electrode, projecting freely into the glass. In connection with the apparatus is a very sensitive galvanometer, and a battery, the negative pole of which is connected to the rubidium, and the positive (through the galvanometer), to the free platinum electrode.

Ordinarily, the gas does not conduct, but as soon as light-rays fall on the metal slice, negative electrons are sent out, the gas begins to conduct, and the galvanometer deflects to a value depending on the intensity of the light.

The use of such so-called "physical" photometers is at present limited by experimental difficulties, but their simplicity may enable them to be of value in the future. The chief difficulty will be to imitate the range of

sensitiveness of the eye to light of different colors. At present, the rubidium photometer, unlike the eye, seems to be most sensitive to violet and ultra-violet light.

The sensitiveness of selenium depends upon the manner in which it is prepared, and it may, therefore, ultimately be possible to reproduce the sensitiveness of the eye throughout the spectrum exactly.

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A New Source of Light

By Otto Vogel.

(From the Zeitschrift für Beleuchtungswesen.)

Wiedemann's Annalen der Physik for 1896 contained a contribution from O. Schott on the subject of a "capillary light."

This lamp consisted essentially of a capillary tube 60 mm. long, and from 0.05 to 0.08 mm. internal diameter, to the extremities of which, thicker glass tubes about 1 to 3 mm. thick, 100 to 120 mm. long, and provided with aluminum electrodes, were attached.

The capillary tube was first open at the ends, but afterwards enclosed, and filled with rarefied gases, which were subjected to the discharge from an induction coil capable of giving a 25 centimeter spark. The tube was also surrounded with a wider jacketing tube with stoppered opening, as shown in the diagram:

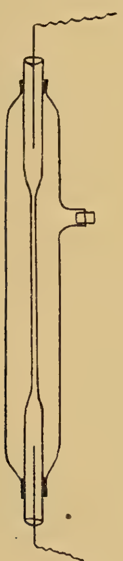

FIG. I.

This outer tube is filled with cooling water or oil. When subjected to the electrical discharge, the capillary tube gives out an extremely brilliant light. But the glass of the tube rapidly becomes too hot to be touched with the fingers, and eventually the temperature becomes so high that the glass begins to conduct. The electrical discharge, instead of passing through the imprisoned gas, then begins to pass through the glass itself, and the light from the tube dwindles away into the weak sodium light yields by the sides of the glowing tube.

By using the cooling jacket described above, the working time of the tube could be extended to half an hour or more before this stage was reached. The spectrum of the light yielded by the tube contains bright lines in the red, yellow, green, and blue, superimposed upon a continuous spectrum. There are also a great number of dark lines, which at first alter their position with each successive discharge, but after a quarter of an hour or so, become stationary. After the lamp has been in use for a short time, the inside of the tube becomes roughened like frosted glass and there are globular widenings of the tube at intervals, which increase the diameter in these regions to really double its original value.

If the diameter of the capillary tube is increased to 0.2 millimeters, the light from the tube becomes less intense and also assumes a red-violet hue. On the other hand, tubes of diameters of as low as 0.02 to 0.03 mm. yield a more brilliant light than those of 0.05 mm. diameter, but reach the roughened state very rapidly.

When the interruptions of the circuit of the induction coil occur 15 to 20 times a second, the light yielded by the tube reaches about 2 H. K. Suppose, therefore, one makes the assumption (not yet justified, however), that during the spark discharge through a capillary tube, the process of light generation lasts only 1/10,000 of a second, as in the case of unconfined air. Then it would follow that the light radiating surface, in spite of its small dimensions of only 1 to 2 sq. mm., would generate about 1,000 to 2,000 H. K., and so outdo the electric arc, if subjected to continuous stimulation. But whether it will be possible to utilize the capillary light for ordinary purposes of illumination, must naturally be regarded as very doubtful.

Electrodes of nickel, copper and iron were utilized in the place of aluminum without altering the general nature of the light yielded by the tube very appreciably.

The use of carbon di-oxide in the tube accentuated the blue region of the spectrum, but the bright lines in the red, yellow, green and blue still remained. In the same way, hydrogen reddened the light yielded by the tube. When the glass tube is closed, and the interior filled with air at a pressure of three atmospheres, the

spark finds it more difficult to pass, than at ordinary atmospheric pressure; otherwise the general phenomena are unaltered. In tubes containing rarefied gases, on the other hand, the discharge takes place with greater ease than in air, and there is no difficulty in increasing the length of the tube to 200 millimeters.

At a pressure of 250 mm. of mercury, the light yielded by the tube is still white, but has already diminished in intensity, and when the pressure is reduced yet further, a reddish-violet coloration appears, the continuous spectrum becomes weaker, and the lines superimposed upon it more pronounced. At a pressure of 3 mm. of mercury only, the tube appears light blue, and the continuous spectrum has completely disappeared. If the exhaustion is caused further still, the visible character of the light ceases entirely, and the radiation from the tube is restricted to the ultraviolet.

Apparently the researches of Schott have not been carried past the stage which we have now described. At all events, no contributions from him describing further experiments have appeared. However, these results might well constitute the subject of further and wider enquiries. We might apply them to the researches of other writers in other fields, notably on the subject of the mercury and fluorescence sources of light.

It has been found that the mercury arc is satisfactorily produced if one adopts the plan, originally devised by the Professors Way and Rapieff, of allowing pure liquid mercury to fall from a vessel through a minute hole in a thin stream, the mercury being received in a bowl fitted with some contrivance by which the liquid can be restored to the original vessel at intervals. Professor Way at first used a stream of mercury vapor 25 cms. long in the open air, but the poisonous properties of mercury vapor soon rendered it advisable to enclose this stream in a sealed glass tube, terminating in the suitable vessels referred to above.

When a P. D. is applied to the mercury in the two vessels at the extremities of the tube, the mercury vapor bridges the tube between them, conducts the current, and in so doing becomes luminescent.

By using both methods, the open and enclosed mercury stream, Professor Way had the satisfaction of producing a very brilliant form of mercury lamp.

In 1879, Professor Rapieff took out an English patent for a very similarly constructed lamp.

A second method of producing the mercury light, is that adopted by Dr. Arons in 1892, namely, to allow the current to cross an air-exhausted space between two mercury electrodes. By so doing, Arons produced a genuine luminesce-light, and the length of the lamp could be extended to 60 centimeters.

Afterwards, Cooper-Hewitt built lamps with a stationary anode, and a liquid mercury cathode, on the same lines as Arons, utilizing an exhausted tube up to 3 meters in length, and half a centimeter in diameter.

In both cases the chief difficulty lay in the production of the electric arc; "tipping" the lamp was adopted as the simplest method of starting the light, so that we may term this type of lamp the "tip-lamp."

Although it is usual to speak of this variety of mercury lamp as an arc light, yet it has quite distinct properties from those commonly associated with arc-lamps, and, indeed, resembles vacuum-tube lights much more closely. For instance, in these lamps the fall of potential is greater at the cathode than at the anode, while in the case of the genuine arc light, exactly the contrary is the case. According to the measurements of Arons, the fall of P. D. at the electrodes amounts to about 13-14 volts, while the fall of P. D. in the mercury stream itself is 0.67 volts per centimeter length. Quite distinct, too, are the results of altering the current through the lamp. An 11-ampere lamp required 17.5 volts, a 2-ampere lamp only 14 volts; yet a 1.4-ampere lamp required 20 volts and a 0.5-ampere lamp as much as 40 volts.

A third method of studying the mercury lamp, which was devised by the author in 1903, involved the use of a completely enclosed arc between carbon electrodes. The lower carbon—the cathode—is completely surrounded by mercury, and communicates its heat to it in such a way that the arc is actually sustained in an atmosphere of mercury-vapor. As a result, the internal resistance of the arc falls to nearly half that of the ordinary enclosed carbon lamp, and, therefore, two mercury lamps of this description can be run in series of 110 volts, and four of 220 volts.

The rate of volatilization of the mercury can be controlled by altering the diameter of the carbons, and the strength of the current. If the development of heat in the lamp, and the cooling action of its

exposed surfaces are suitably related, the mercury vapor itself becomes the chief source of light-emission, and the lamp shines like a veritable sun—a sun, of course, composed of incandescent mercury vapor.

In the most favorable direction of emission, a 12-ampere arc yields as much as 3,200 H. K. The cross-section of the illuminated globe in the direction of light-emission is about 54 square centimeters, so that the light-density of the source works out to about 60 H. K. per square centimeter. Under less favorable conditions, 22 H. K. are obtained, but the lamps of Hewitt and Recklinghausen are only credited with 3 H. K. per square centimeter of radiating surface, while Way's original lamp, of course, yields considerably less.

In the "tip-lamps," the temperature of the central position of the column of mercury vapor is as high as 500 degrees, while the temperature near the walls of the tube is, on the contrary, only about 70 degrees. The fall of potential is 0.67 volts per centimeter of vapor, according to Aron, and 0.3 volts per centimeter according to Hewitt.

Both these authorities seem to consider that the most favorable efficiency of light-production by the mercury "tip-lamp," has been reached, but other workers claim to have reached higher results, and believe it possible to do better still.

Heräus, of Hanover, has stated that he has been able to reach 0.17 watts per H. K., while 0.6 watts / H. K., or under unfavorable conditions, even 1 to 1.3 watts per H. K., is all that has hitherto been possible.

It has already been remarked that these "tip" or tube lamps are operated at a very high vacuum, ranging from 0.2 to 100 millimeters of mercury. This accounts for the high value of the fall of P. D. through the mercury column. Now, Schott, von Recklinghausen, Hewitt, etc., have found that the efficiency is a maximum at a certain low value of the internal pressure of the tube, that with increasing pressure the efficiency falls off, and that the limit of practical usefulness is reached with a P. D. of 3 to 4 volts per centimeter of mercury vapor.

Heräus bases his opinion upon the possibility, that though it may be true that 3 watt per centimeter and over is uneconomical, yet it does not follow that higher values up to 25-30 volts per centimeter will also be found so.

Under these conditions, a lamp intended for a P. D. of 110 to 220 volts would only require a tube 6 to 15 centimeters long, and, in spite of the smaller tube, the total yield of light might be so great as to justify Heräus' statement.

The glass in such a lamp would certainly have to be of excellent quality, in order to withstand the inevitable stress and high temperature which would follow, but we should gain the great compensating advantage, that the present luminescence of the mercury vapor would be replaced by temperature radiation, and a much more intense light might be reached by this means than in the exhausted tube lamps. This is the conviction of Heräus, whose tests have shown that a very intense, stable, and pleasantly colored light ensues if a narrow tube of about 5 mm. internal diameter is used. In this case we utilize mercury vapor of much greater density, but also much higher temperature than is usually the case, and this accounts for the advantages referred to above.

It is now possible to secure glasses which can withstand a high temperature, and, in spite of their glowing condition, still possess very considerable strength. It is even possible to melt rock crystal and quartz, and to construct lamp vessels out of them.

To these methods the quartz glass of Heräus and the "Uviol-glass" of Schott and Gen, owe their remarkable properties. The latter, in particular, exhibits a complete transparency to ultra-violet rays which ordinary glass does not possess, in that it not only suppresses these rays, but loses its consistency under their influence and become electrolytically decomposed.

Moreover, there are liquids in the form of salt-solutions, with which Nature has provided us, and oxides of metals and so forth, which chemical industry has put at our disposal—in short, materials of every description, which shine with a more or less bright luminosity in various colors, under the influence of ultra-violet light.

In the case of many materails, this reaction is a mere fluorescence, but in others it certainly gives the impression of being based upon a dormant capacity for radiation, which is only called into activity by the influence of ultra-violet rays.

These properties of substance are already of practical value in a few cases—in the form of luminous paints, and fluorescent screens.

When we call to mind that, in the mercury lamp, two-thirds of the total energy

generated, takes the form of ultra-violet light, and only one-third is visible, we can realize at once the importance of in some way converting the lost ultra-violet energy into a visible form. If we could succeed in doing this, if, by the transformation of these rays we could generate just those colors—the red, for example—which are wanting in the spectrum of the mercury lamp, it would probably enable the mercury lamp to dominate all other sources of light, on the ground of intensity and economy.

Let us now turn to the possible practical application of the researches considered in the initial portion of this article.

Schott, in his account of the capillary light, pointed out that the intensity of the light diminished, as the exhaustion of the tube proceeded. Eventually, the continuous spectrum disappeared, and was replaced by a line-spectrum, and at last the radiation was shifted into the ultra-violet.

We must, therefore, endeavor to avoid these conditions which are unfavorable to the intensity and color of the light produced, and to the production of a continuous spectrum.

The experiments of Way have taught us that only a very minute stream of mercury-vapor is necessary for the creation of an intense arc, which, in consequence of the rise in temperature following the use of a sufficiently strong current, may assume the state of temperature radiation. In order to secure this condition we must avoid the use of exhausted tubes, and the excessive superficial cooling area presented by them, and also sudden and excessive cooling of the vapor. We know, too, that as the temperature of the stream of mercury, and the fall of P. D. along it, is increased, the power expended in the stream must also increase, in order to maintain the conditions favorable to pure temperature radiation. We must, therefore, choose such materials, and so design the parts of the lamp, as to withstand the exceptional strain to which the lamp must be subjected by the increased temperature and pressure.

The great difficulty experienced in the starting of the "tip-lamp," must be a warning to us not to fall into the same mistake in the design of our lamp. We ought, therefore, to avoid the production of a vacuum between widely-separated mercury electrodes, and rather to endeavor to secure that, after extinguishing the light, the necessary bridge of metallic vapor is automatically reformed, so that, when we desire to light the lamp again, the production of light immediately follows the formation of electric contact.

And, lastly, we may point out once more the desirability of converting the ultra-violet radiation into visible light, and, if possible, light of a red color. If we could simultaneously secure necessary cooling of the lamp, this would be an additional advantage.

But it must be noted that any cooling-device must not depend upon the external conduction of heat to and from the lamp; this would render the method valueless in practice.

These are the fundamental considerations by which the designer of this problematical lamp must be guided. They are given to the public with no restriction, and he who feels himself called upon to undertake the work, is free to do so!

New Books

ELECTRISCHE BELEUCHTUNG (Electric Lighting). *By Berthold Monasch.*

Dr. Berthold Monasch is a known investigator and writer in the field of electric illumination. The "Electrische Beleuchtung" was written by Dr. B. Monasch at the request of the publisher Alex. Koenigswerther for his small library of books on electrotechnics. This small library consists so far of twelve volumes on twelve branches of electrotechnics, each written by an authority on the subject treated. The book to be reviewed by us here presents the eighth volume of the library.

Dr. Monasch undertook the task of writing a purely technical book for practical use the more gladly, as he realized the misuse of photometric data in illuminating engineering and wanted to correct the tendency in that direction.

In the preface the author laments the confusion of photometric terms, as for instance, light-efficiency, light-flux, illumination and surface-brightness. This confusion leads to endless misunderstandings between the consumer, the official institutions, central stations and lamp manufacturers.

American illuminating engineers can but sympathize with the author in his laudable attempt to bring rational order into the chaos of photometric terminology. He uses the terminology adopted by the International Congress of Electricians in Geneva, Switzerland, in 1896 and approved by the German Electrotechnical Society and association of German "Electrotechnischer" at their joint meeting in Eisenach, June, 1897.

Dr. B. Monasch, however, expressed the opinion, that the time is ripe for a revision of this authoritative terminology. He especially points out the incongruity of calling the wattage (watts per candle-power) of an electric-light system—its efficiency (economy), a term self-contradictory as efficiency and wattage are inversely proportional to each other, *i. e.*, the lower the wattage, the higher the efficiency and not vice versa. He proposes the substitution of the term "Specifischer Effect-Verbrauch," a term not very easily rendered into English without some circumlocution but expressing the ratio between the energy consumed by the electric light system in question and the quantity of light produced by it.

The book is divided into eight parts. The first part is devoted to photometry, the second to arc lamps, the third to incandescent lamps, the fourth to the wiring system of various lamps, the fifth to installation and trimming of electric lamps, the sixth to light-emission, the seventh to light-efficiency and the last to practical illumination problems. A very good index fittingly follows and supplements the text elucidated by many cuts and tables.

Dr. B. Monasch distinguishes between bodies giving light at comparatively high temperatures (incandescent luminosity), and bodies giving cold light (luminiscent luminosity), *i. e.*, between black bodies with continuous spectrums and white bodies with band-spectrums and selective radiation. The illuminants of the latter kind he only mentions and dismisses with the remark that they are not investigated with sufficient assurance.

Curious is the proposal, never realized, however, to sell illumination on the basis of lumen hours instead of kilowatt hours.

The book is written with the characteristic German thoroughness and system for technical men by a technical man, who possesses all the advantages of theoretical knowledge and the insight of an original investigator.

The volume can be cheerfully recommended to illuminating engineers and all others interested in the science and art of illumination.

Grundzuege der Beleuchtungstechnik (Fundamental Principles of the Technique of Illumination). *By L. Bloch.*

The author, Dr. L. Bloch, is an engineer in the service of the municipal electric works of the city of Berlin, Germany. The book represents a revised and readjusted reprint of the articles published during the last few years in the *Journal für Gasbeleuchtung* and *Electrotechnische Zeitschrift.*

The object of the volume to be reviewed here is not to replace but rather to supplement the existing standard works on electric illumination in a direction so far almost neglected, namely, in measuring, calculating and estimating various illuminating systems on a thoroughly scientific and technical foundation. The growth and development of the science and art of illumination and the

intensified struggle for existence between various systems of illumination and finally the enormous increase in the public demand for better and more efficient light make such a book as "the foundation of illuminating technology" or rather "illuminating engineering," by Dr. L. Bloch a necessity.

The experimental and practical material dealt with in the book is worked up from the data of the electric works of the municipality of Berlin.

The volume contains six chapters and a supplement consisting of curves and tables for practical use and references.

Chapter first deals with the fundamental principles and values of illuminating engineering, the second chapter is devoted to the measurement and calculation of illuminants; the third chapter treats of the principles on which an estimate and valuation of a system of illumination had to be based, the fourth chapter is occupied entirely by mathematical photometric data to be used in practical light installation and industry, as it is being met with by every illuminating engineer in his every-day practice in the discharge of his professional duties.

The fifth chapter takes up the measurement of illumination and the last chapter treats the subject of indirect illumination.

Very ingenious is the author's elucidation of the fundamental principles, for instance the elucidation of the terms: flux of light, illumination, and luminous intensity.

Let us suppose a sand-blast in the center of a hollow globe, the inner surface of which is made adhesive and let us further suppose that the law of gravity is eliminated.

The sand will then be thrown from the center of the globe towards its inner wall in all directions radially and perpendicularly with various intensity. This variation in the intensity of the impact will effect variations in the thickness of the layer of sand adhering to the inner wall of the globe. In a certain time a certain quantity of sand will be projected on each point of the inner surface of the hollow globe. Let us now replace the sand-blast by a source of light and we will have a more or less correct conception of a flux of light during a fixed period of time.

The derivation of other terms is explained in the same way and manner. For instance, the thickness of the layer of sand adhering to the inner wall of the hollow globe is identified for the sake of elucidation with illumination, etc., etc.

The analogy is a rather happy one.

In view of the Babylonian confusion of languages prevailing in the domains of photometrical terminology it will be probably of interest to give here the following authoritative definitions:

Lux (Symbol Lx) a unit of illumination equal to a source of light of one Hefner-candle at the distance of one meter produced on a surface perpendicular to the direction of the radiation.

Lumen (Symbol Lm) is the unit of a flux of light of a source of light radiating in all directions with the intensity of one Hefner-candle in the solid angle 1. That means an angle cutting from a globular (spherical) surface of the radius of 1 meter a surface of one square meter.

Lumen-Hour or Lumen-second is the unit of light-emission.

Lux-Second is the unit of one lux of illumination during a second of time. A surface brightness unit is the surface brightness of source of light of one Hefner-candle produced on a surface of 1 square meter.

The Rousseau method of measuring spherical and hemispherical candle-power requires the use of the somewhat cumbrous planimeter. The author devised a simplification of Rousseau's method, doing away with the necessity of using a planimeter and giving results satisfactory in every day practice.

The arrangement is exemplified in the attached drawing.

The diameter K. G. is divided into twenty parts, one centimeter each, K. G. being equal to 20 cm. The corresponding value of candle-powers of each point on the curve of light distribution is taken for each center as in the ordinary Rousseau method.

The twenty values so attained are added, and their sum divided by 20. This value furnishes the average ordinate of the Rousseau curve and also the average spherical c.p. Taking only the sum of the ten lower hemispherical values and dividing them by ten, we get the lower hemispherical c.p. and so on.

Dr. L. Bloch is of the opinion, that the comparative values of different sources of light for practical illumination is most conveniently expressed in their respective average hemispherical c.p.

Following are the data for electric lamps:

1—Incandescent carbon filament lamp, Av. Hemisph. watts per candle	4.0
Incandescent metallized filament lamp	2.7
Nernst lamp	2.0
Tantalum lamp	2.1
Osmium lamp	1.8
Tungsten and Osram lamps	1.3
2—Vapor arc lamps	...
Ordinary mercury arc in glass tube	0.9
Ordinary mercury arc in quartz tube	0.4
3—Direct current carbon arc, 8 amperes	0.85
Direct current carbon arc, above 8 amperes	0.6
Miniature carbon arc	1.1
Inclosed carbon arc	1.0
Flaming arcs with carbons superimposed	0.4

The effect of reflectors on lamps whose lower hemispherical light flux is equivalent to 40 to 55 per cent. of the entire flux of light without reflectors, the percentage of lower hemispherical light flux can be augmented by proper construction to 60-80 per cent.

The loss by absorption due to reflectors amounts on the average to about 5-21 per cent. of the average spherical c.p. without a reflector.

In estimating the actual street illumination of a given system the author recommends to take into consideration the horizontal as well as the vertical illumination. The horizontal illumination is to be measured at a distance of 1.5 m. from the pavement-surface.

As a criterion of the economy of a system of illumination the author recommends the ratio between watts per candle per time unit (hour for instance) and surface unit (for instance 1 m) illumination.

The mathematical part of the book dealing with the best methods of calculating luminous values and their various aspects and combinations is remarkably concise, lucid and simple.

Numerous tables, formulas and diagrams facilitate the perusal of the book.

For eminently useful and thoroughly practical treatment of the subject the volume has no rival in the rather scant and for the most part antiquated literature on illumination and illuminants.

Dr. L. Bloch's book deserves to be translated into English and ought to find a place in the library of each and every man having to deal with illumination in all its ramifications, and especially ought to be kept as a *vade mecum* by all illuminating engineers.

Miscellaneous News

BUFFALO, N. Y.—Mayor Adam sent to the Aldermen recently a communication calling attention to the need of better street lighting, of extension of gas mains and of a better understanding generally with the Buffalo Gas Company. He suggests that the Public Utilities Commission be called upon to decide how far the gas company can be compelled to extend its mains so that lamp districts may be extended. On the subject of better lighting the Mayor points out that the last contract expired March 1 and that since then Welsbach burners have been taken off some important streets, to be replaced by old flat flame burners.

HERNDON, VA.—A company has just been organized in Herndon for the purpose of lighting the business and dwelling houses by means of acetylene gas. Those forming the company are Dr. E. L. Detwiler, A. T. Walker, E. N. Walker, Dr. E. L. Robey and F. W. Huddleston.

HERMOSA BEACH, CAL.—By unanimous vote the advisory committee of the Hermosa Beach Improvement Association has pledged itself to secure a municipal electric lighting plant for this city. Property owners from every section of the town are members of this committee, and the city trustees, who in most things follows the advice of these citizens, are said to be a unit in favor of the enterprise.

MILLERTON, N. Y.—The Millerton Electric Light, Heat and Power Company has been formed with a capital of $7,500 for the purpose of giving the village electric lights and a trolley line. J. Henry Roosbach and H. E. Lyle of Canaan, Conn., and Daniel W. Gleason of Millerton are the organizers.

NEWARK, N. J.—At the recent elections the voters gave a majority of 12,000 in favor of the city establishing a municipal electric light plant.

NASHVILLE, TENN.—The proposition to establish and operate a municipal electric lighting plant has been voted down in the local municipal election by a vote of 1,353 to 860. Of the twenty-five wards in the city, only five were favorable.

OGDEN, UTAH.—Angus Wright, in behalf of the Weber club and business men interested in the preservation of the special lighting system, addressed the council in behalf of business which he declared is materially increased by the presence of the lighted lamps over the streets. He asked that for the good of trade, and as an advertising medium, the lights be again made serviceable.

PASADENA, CAL.—Because of lack of funds the working force of the municipal electric lighting plant may be crippled within a few days, as it is deemed necessary to lay off eight or ten of the workmen. Superintendent Glass has been utilizing his working force as fast as possible to complete the extension of the lighting system.

ST. LOUIS, MO.—Dissatisfied with the prices they are paying for electric light, citizens of St. Louis County are discussing plans for the organization of a company to compete with the corporation now furnishing electric light in the county. It is proposed that a stock company be formed among citizens and that a plant be established in the neighborhood of Clayton.

WASHINGTON, IND.—By a vote of 329 to 44 the people of this town have rejected a scheme for remodeling the municipal lighting plant, notwithstanding the alternative presented by the Common Council of providing for extensive repairs or eventually abandoning the business of municipal lighting. The plant has fallen behind year after year, although liberal appropriations have been made for its support, and repairs have been neglected till it is little better than a mass of junk.

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Memorandum.

Meeting of the National Commercial Gas Association, New York, January 8, 9, 10.

Entered as Second Class Matter January 13, 1907, at the post office at New York, N. Y.

The word "home" and the thing which it stands for, belong distinctly to Anglo-Saxon civilization. There is no other institution so jealously guarded by law and custom. Whatever will in any way add to the stability and influence of home is therefore of pre-eminent importance. The one time when the home attains to the full meaning of the word is the evening. And what would the home be in the evening without light?

What incident in the life of the great Lincoln is more fascinating to the young mind than the story of his reading law books at the hearth-stone before the blazing wood fire of his log cabin home? Both the cabin and the fireplace have practically disappeared from the life of to-day, and with them a certain element of primitive ruggedness and simplicity of character.

This may be properly called the age of Light. At no time in history has artificial light been so universally used. That which is common is often both unappreciated and abused; and this applies in a large measure to the magnificent light-sources which modern science has developed. Good lighting is within the easy reach of the humblest home to-day; and yet through carelessness and lack of knowledge bad lighting is only too common. This should not be. All that is required to make the home of to-day better than the palaces of olden times is a little study of the subject, and a right use of the numerous modern lighting devices.

THE ILLUMINATING ENGINEER *is endeavoring to promote the cause of good lighting. We wish to be helpful in the highest possible degree to every user of light. We therefore earnestly say: if you are in any way dissatisfied with the illumination that you are now using, tell us what your troubles are, and why you are dissatisfied. We will give your case careful personal attention, and give you the fullest and most helpful advice within our power.*

We want our readers to feel that THE ILLUMINATING ENGINEER *is not merely so many sheets of printed paper, but a personal messenger of light and knowledge on a subject in which every civilized human being is interested.*

E. L. Elliott.

Charles Philo Matthews, Ph. D.

Born September 18, 1867, at Ft. Covington, N. Y.

Graduated from St. John's Academy, 1887; Cornell University, 1892; Doctor of Philosophy, Cornell University, 1901.

Professor of Electrical Engineering, Purdue University, 1905-1907.

Four years photometrist for the committee of the National Electric Light Association appointed to determine the photometric values of arc lamps. His reports, covering over 200 pages, form a classic on this subject.

Inventor of an integrating photometer for determining the spherical candle-power of both arc and incandescent lamps, which received a gold medal from the St. Louis Exposition.

A thorough scientist, a modest, patient, gentle man, always thoughtful and helpful of others.

THE ILLUMINATING ENGINEER

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The Evolution of Interior Lighting

A FIRE of wood in the cave inhabited by prehistoric man furnished the first example of interior lighting. Fibrous bark soaked in animal fat was the progenitor of both the candle and the oil lamp. In point of time, the lamp was probably developed first, and had come into use while man still lived in caves. A lamp and stand having reindeer ornaments traced upon it was found in the Province of Dordogne, France, and is supposed to belong to the geological period known as the "quartenary." The ancient oil lamp consisted merely of a shallow bowl for holding the oil, and having one or more spouts, or nozzles, about the size for receiving the wick. Lamps of this general character have been found in prehistoric remains in the most widely separated parts of the world, showing their independent invention.

The first steps in the evolution of lighting were the result of simple observations relating to fire. The discovery of the combustibility of fats would naturally follow the first attempts at roasting meat, and a means of maintaining a small flame for a comparatively long period of time by gradually supplying it without oil or fat would be the next step in the evolutionary process. The formation of solid fat into a candle involves a somewhat more complicated process, and therefore undoubtedly followed the invention of the oil lamp.

Having progressed to the stage of producing a small continuous flame for the purpose of supplying light only, the next problem was to arrange for placing light-sources so as to furnish the desired general or special illumination. The lamp or candle could be readily moved about, and placed on any temporary support, as convenience might dictate; but as more labor began to be performed, the necessity for a more convenient and permanent location of the lights naturally arose. The lamp belonging to the geological period above mentioned was supplied with a special standard for its support, thus showing that the second step in the evolution had been reached. There are only two ways of supporting a

light-source, namely, either from underneath, or by suspension from an overhead support. The overhead support may be either the roof of the building, or an arm or bracket projecting attached to walls or other supports. Thus all four possible methods of placing light-sources were developed in the very earliest periods, namely:

First, portable lamps having no special place for their support. (Portables).

Second, lamps supported on standards or columns, (Candelabra).

Third, lamps suspended from the ceiling (Chandeliers).

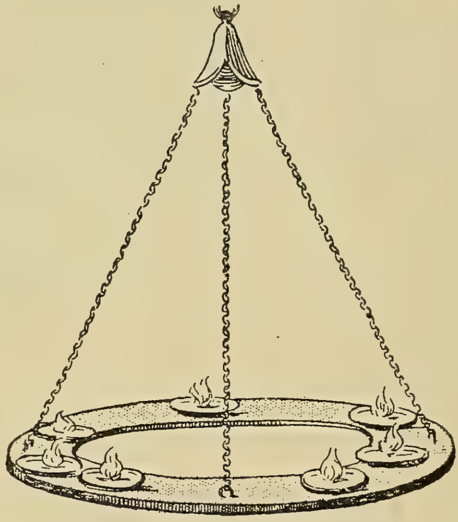
Fourth, lamps suspended from, or resting upon, projecting supports attached to side walls. (Brackets.)

In the most elaborate and most magnificent buildings of the present time, the architect is confined to a choice of these four methods in placing light-sources.

It is a remarkable fact that, in the evolution of the various handicrafts, decorative motives were co-temporaneous with, and sometimes even preceded the desire for utility. Thus, Herbert Spencer has shown very conclusively that in the evolution of dress, the desire to ornament rather than to protect the body was the primal motive. The ornamentation referred to on the prehistoric lamp may be noted in this regard.

The specifications given to Moses for constructing the seven-branch candle-stick which was to be the principal illuminating device of the Tabernacle, may perhaps be considered the first case of illuminating engineering. The directions given are so explicit that the fixture in substantially the form originally constructed is still in use in many church edifices.

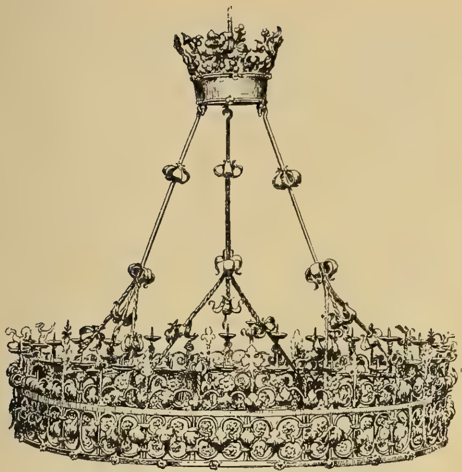
The chandelier, consisting essentially of a common support for several lamps or candles, seems to have been first developed in ancient Rome. They are described by contemporary writers as being made of bronze, and of elaborate and beautiful workmanship, but they were only used in public buildings. The ordinary arrangement for residences consisted of a lamp having a single bowl, and from one to three burners. These were suspended in doorways or from ceilings for general illumination. But when better illumination was required for special purposes, such as the lighting of dining tables, or of rooms used for festivities, it was obtained by living candelabra in the shape of slaves holding



CHANDELIER, FROM FRESCO IN THE CHURCH OF ST. LORENZO, ROME.

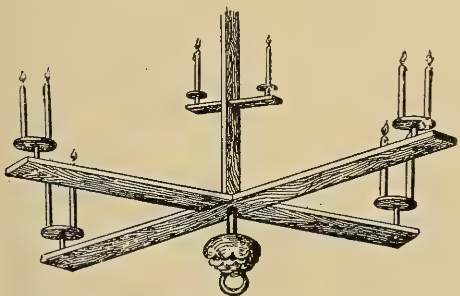
torches or lamps. Needless to say, this method was only used by the wealthy classes. The simple, crude hand lamp probably furnished the only interior lighting of the common people.

The scheme of arranging a common support for a number of light-sources, either lamps or candles, is so elementary that it was developed independently in different parts of the



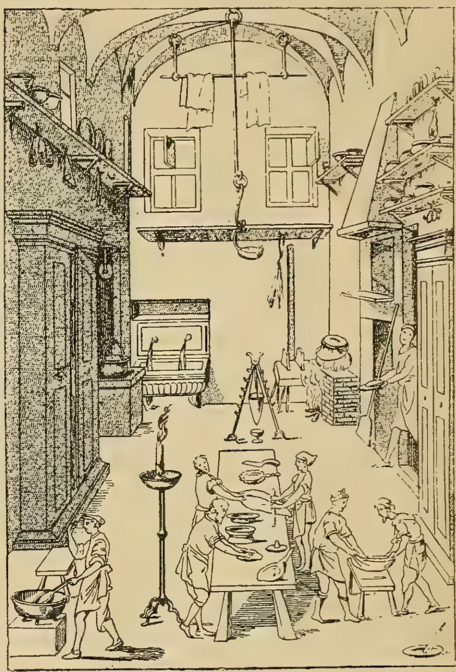
CORONA CHANDELIER, CHURCH OF ST. PETER, BASTONGES, BELGIUM.

world. A single ring of metal upon which lamps were placed, and which was supported by three chains from the ceiling, is shown in a fresco on the walls of the church of St. Lorenzo in Rome, and depicts a type of fixture which was evidently in use as early as the sixth century. From this primitive design the Corona fixture was evolved. These fixtures were used in lighting the earliest of medieval churches, and attained very large proportions and were worked out in elaborate designs. As they reached their highest state of development in the period of the Crusades, it is not surprising to find them symbolizing, both



SIMPLE WOODEN CHANDELIER OF THE XV. CENTURY, THE PROTOTYPE OF THE MODERN FIXTURE.

in their general design and ornamentation, the walls and gates of the Holy City. These were described somewhat in full in THE ILLUMINATING ENGINEER of October, 1906. The circular, or Corona type of chandelier, however, as developed in England and Belgium, exhibits some exquisite designs in wrought iron, an example of



A KITCHEN OF THE XVI. CENTURY.

which is shown in the accompanying cut. This type reached its perfection in the twelfth century. These magnificent chandeliers, however, were confined entirely to the churches. Residence lighting was still of the simplest kind. The illustration, taken from a drawing of the sixteenth century, shows the lighting of a kitchen, which is accomplished by a large candle on a standard and an oil lamp hanging from the ceiling. The dimness of the illumination, considering the size of the room, can readily be imagined.

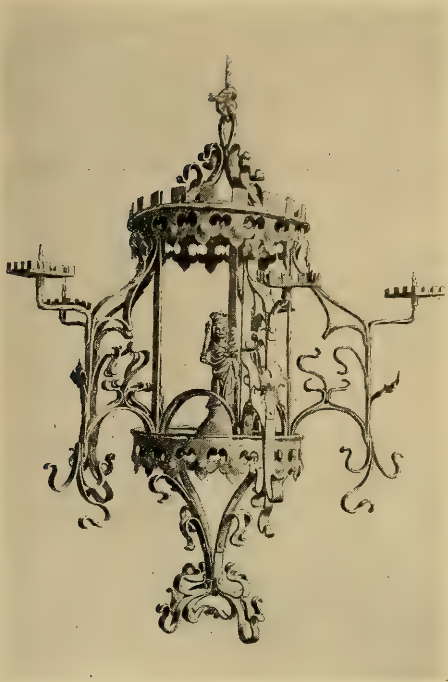
In the latter part of the fifteenth

CHANDELIER OF CARVED WOOD AND WROUGHT IRON, CHURCH OF CALCAR, NEAR TRÈVES, XV. CENTURY.

century chandeliers constructed in the simple manner of boards placed crosswise and holding candles were frequently used. The readiness with which these could be made on short notice facilitated their use for special occasions. Some beautiful chandeliers made of carved wood in combination with delicately wrought iron, and bearing statues of the Virgin and other religious devices, were constructed in this period. The chandelier had by this time found its way into the dwellings, at least of the aristocracy, as shown by an illustration taken from a contemporary manuscript.

From this time on the artistic chandelier was developed in different countries of Europe. The illustrations show specimens of Venetian, German, and Flemish designs in metal. The leadership, not only in the design of fixtures themselves, but in their treatment as parts of the architectural and decorative scheme, has always been taken by France. During the seventeenth century art was practically a department of state in that country, and was dominated by the master mind of Charles Le Brun. This was the golden age of decorative art, and the lighting fixture of all kinds designed during this period remain as master pieces. Glass was largely used as a decorative material, although not to the exclusion of metal, and the metal work was of surpassing beauty of design and workmanship. Specimens of both glass and metal fixtures of this time are shown in the illustrations. These magnificent creations, however, were found only in the palaces and chateaux of the nobility, or wealthy classes, and the churches. Domestic lighting was still of a very simple order. The invention of the lamp with a circular wick and glass chimney by Argand in 1782 was the first real improvement in the

DINING-ROOM LIGHTING OF THE XV. CENTURY.

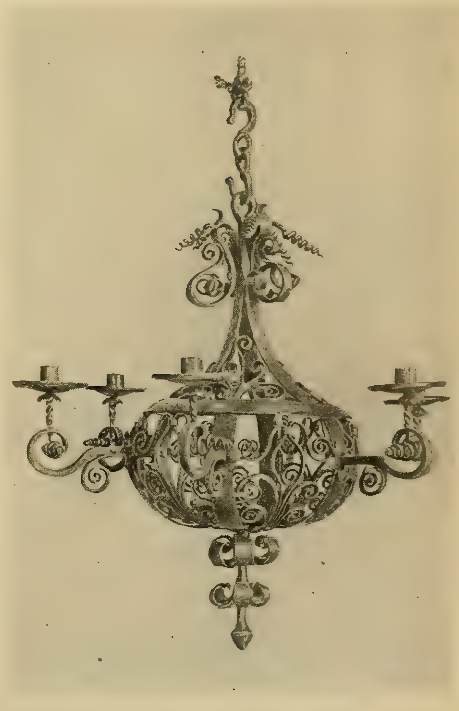


GERMAN CHANDELIER IN WROUGHT IRON, XVI. CENTURY.

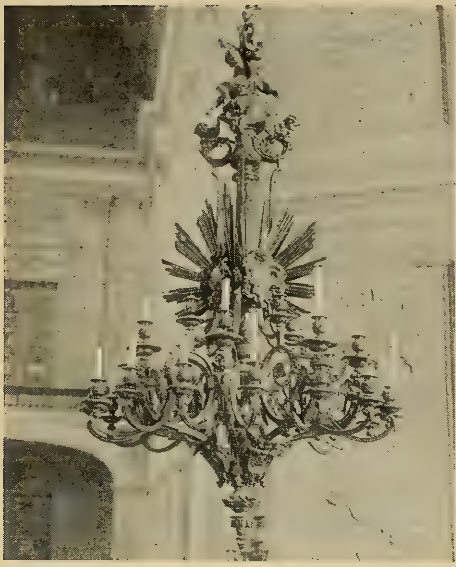
means of producing light for general use that had been made since pre-historic time. The candle to-day gives no better light than it did in the time of Moses; but the oil lamp of Argand, with its brilliant, smokeless flame, was an enormous improvement over the little yellow flames of the old fashioned oil lamps.

The commercial introduction of illuminating gas at the beginning of the nineteenth century was the first step in the revolution of both interior and exterior lighting, which has attained such magnificent proportions at the present time. Systematic public lighting began with the use of illuminating gas. When used for interior lighting the chandeliers which had been designed to hold candles were simply adapted to burning gas; no new types were developed. The finer specimens were made of glass tubing, decorated with cut ornaments after the manner of the crystal chandeliers of early periods. As these were necessarily expensive, a type of cheap fixture in metal was evolved. This consisted of cast-iron troughs, variously shaped, in which the iron gas pipes were concealed. They were generally finished by copper plating to imitate bronze. From the artistic standpoint they were fit companions for the chromo-lithographs and colored prints that may still be occasionally found in their company in houses that have kept their furnishings untouched for the past thirty years or more. Tons of these fixtures were turned out at the Sing Sing prison.

Following this period of cast-iron and copper plate, the style of art generally known as "Eastlake," but more properly described as gingerbread, came into vogue, and found its way into both architecture and decorative



FLEMISH CHANDELIER IN WROUGHT IRON, XVI. CENTURY.



METAL CHANDELIER IN THE PALACE OF VERSAILLES, LOUIS XIV.

With the advent of the electric light some thirty years ago there was introduced a light-source which offered an entirely new field for fixture design. For a long time, however, absolutely nothing new in principle was developed. The chandelier that had supported candles in the time of Louis, and gas burners in the time of our grandfathers, simply had electric lamps attached in place of the older light-sources. Generally speaking, there has been very little devel-

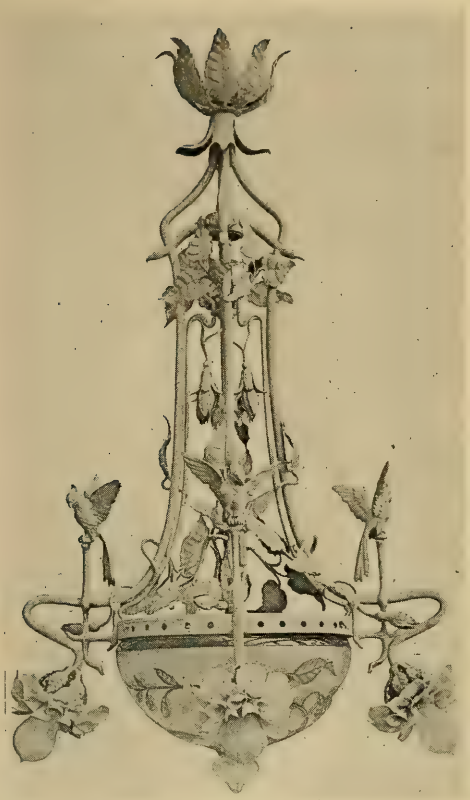
BRACKET IN THE "LITTLE TRIANON," LOUIS XVI.

oped that is essentially electric. By far the larger amount of designs up to the present time are nothing but adaptations of the designs that originated in France a couple of hundred years ago. The almost unlimited possibilities for decorative effects of the electric light have yet to be discovered, in an artistic sense.

The only innovation is the school of decorative art, which takes the name of Art Nouveau. The school might be called the "natural school." The motifs

art. The fixtures were made of light brass tubing, with flimsy brass stampings, variously distributed about the arms. The finish was generally bright polished brass. Examples of this type are still comparatively common.

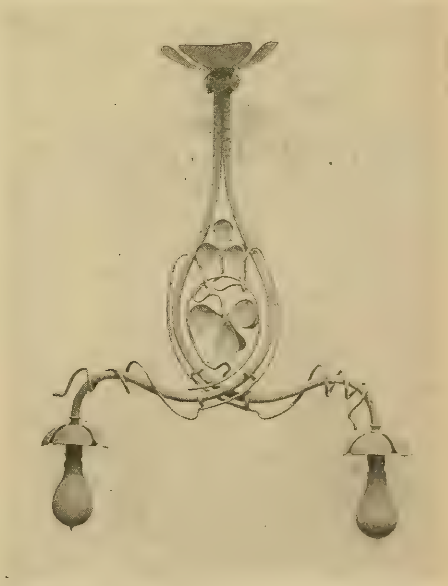
CRYSTAL "LUSTRE," OF THE EMPIRE PERIOD.



MODERN ART NOUVEAU CHANDELIER.

are taken from the forms of plants and animals, without their being conventionalized, as was the case in all previous schools of design. Much has been accomplished, and much is to be expected from this school of decorative art. Nature is never a bad guide, and her resources by way of variety of forms are inexhaustible. Fixtures of this type have scarcely been touched upon by American manufacturers, but many beautiful specimens are shown in foreign catalogues, some of which have previously been illustrated in these columns.

The impetus given to artificial lighting by the advent of gas was greatly augmented by the electric light. The discovery of petroleum and the improvement of lamps for burning it has, in addition to the improvements offered by electricity and gas, made the present a period of universal light. The common dwelling of to-day, in point of brilliancy and general effect, is illuminated better than the mansions and palaces of antiquity. So far as brilliancy and quantity of light is concerned, there is nothing more to be done in the way of interior illumination; in fact, there are many cases in which the fault is one of excess in this regard. Further improvements in interior lighting must therefore be in the way of a nearer approach to daylight in point of diffusion, color, and ease upon the eyes. What the future will bring forth in this regard it is impossible at the present to predict.



ART NOUVEAU CHANDELIER, BY CHAS. BLANC, PARIS.

Gas Light in the Home

By George G. Ramsdell.

PROPER lighting of the home requires, briefly, an ample volume of light suitably arranged, and so distributed as to secure proper results—such as protecting the eyesight, adding to, instead of detracting from, the pleasure of reading, writing, etc.; increasing the attractiveness of the home and its furnishings, and contributing its full share to the interior of the home itself.

"All the comforts of home" implies that, among other things, the home must be suitably lighted. No one feature of our domestic comfort, in fact, is more important than the proper illumination of the rooms in which we spend the hours between night-fall and bed-time.

The field of home illumination is, at present, principally occupied by gas and electricity, each having their good points; but as the limits of this article prohibit discussion of their relative merits, we shall, therefore, confine our views to the subject from the gas standpoint.

It is only within the past five years, or since the advent of the inverted gas lamp, that it could be safely claimed that gas could be used with better results than any other illuminant, all

FIG. 1.

FIG. 2.

conditions being taken into consideration.

Remarkable improvement has been made in recent years in this particular field, and present conditions are vastly superior to former practice, which is largely due to the fact that intelligent study of the subject by illuminating engineers and their exposition of their discoveries has added largely to the general knowledge along this line.

It has been stated as an axiom that seven years is required to fully complete any invention. It is nearly seven years since the introduction of the inverted lamp. Its development to its present perfected state has been gradual, but I think any candid person who has looked even superficially into the matter will agree that further developments and improvements in the inverted field will have to do more with the fixtures than with the lamp itself.

The inverted gas lamp as it is marketed to-day by the originators of the inverted idea possesses every requirement of a perfect illuminant for practically every place where artificial light is used, but its most important field, as its advantages become more and more known, will be residential illumination.

Inverting the light throws practically all the light downward where it is useful, and but a small part above the center where useless. It possesses the further advantage of yielding a soft, white, mellow light neither tiresome nor injurious to the eye, is free from obnoxious rays, cannot injure or smoke ceilings, and possesses a still further and most important feature—a marked economy — all of

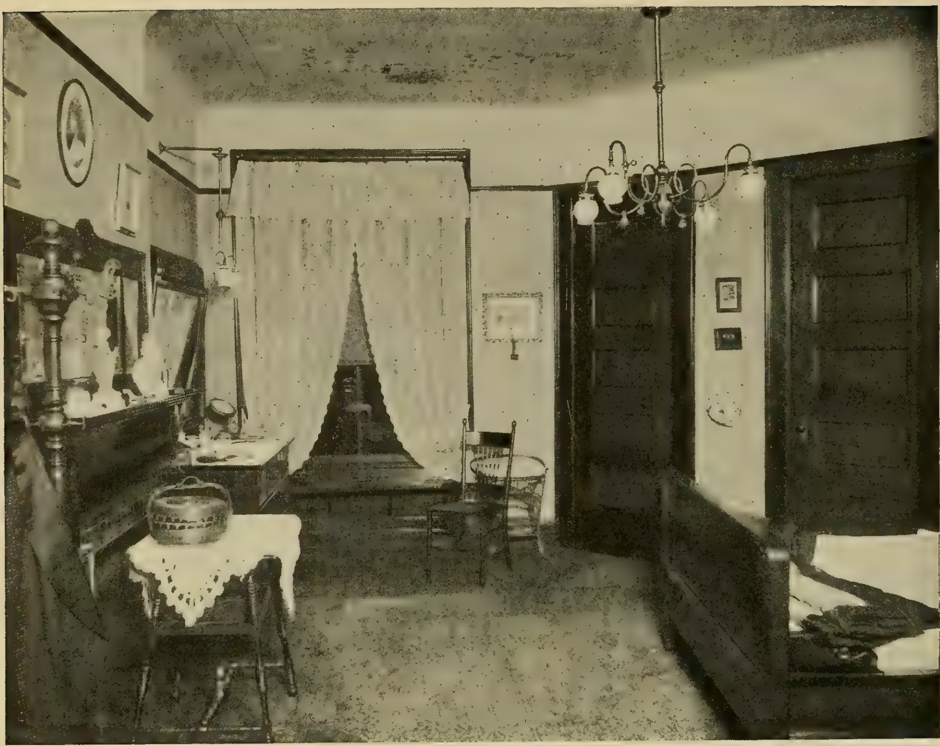


FIG. 3.

which features are pronounced and meritorious.

The proper lighting of the home requires a systematic arrangement as to number, size, location and decorative effect. It is apparent that the same volume of light required for a bath room would not be appropriate for the kitchen, but fortunately we have inverted lamps of a smaller size that makes it possible to meet any requirements as to volume by simply multiplying the unit.

In my opinion it is a mistake to use the larger inverted lamp in the home, except in rare instances. Electrical engineers who have given this subject a vast amount of careful study and experiment confine their house lighting to the small unit, and in fact very largely in the lighting of large areas confine themselves to the same unit, simply multiplying the number to reach the necessary volume of light required, which is unquestionably correct, artistic and indicative of the highest art.

The small inverted gas lamp consuming one foot of gas per hour and giving twenty candles of light is, therefore, a most desirable unit. Any desired volume of light may be secured; from a single lamp in a bath room to a cluster of lamps suitable for any room of any size. The few illustrations which are given are all installations where existing fixtures have been utilized and which, therefore, exhibit effectiveness rather than artistic qualities. For example, the dining room should have, instead of the large and expensive chandelier, a handsome 24 or 32 inch art glass dome over the table with three or four Bijou lamps

under it, the expense being no greater while the artistic result would be infinitely greater. We were unable in the brief time at our disposal to secure a photograph of this kind, although such installations are numerous and are giving perfect satisfaction.

The illustrations, however, show a few rooms exceedingly well lighted and which are in daily use and very much appreciated by their owners.

PARLOR.—Fig. 1 is a photograph showing the arrangement of light for a parlor using six small lamps arranged on an existing chandelier. Two of these will light the room very nicely and three abundantly, but to preserve the appearance of the chandelier each arm was provided with a lamp.

DINING ROOM.—Fig. 2 shows the neat and effective way in which a dining room having an ordinary chandelier at least two or three times larger than necessary may be brilliantly lighted and the existing chandelier utilized. This chandelier, in addition to a 14-inch dome in the center, has nine arms in clusters of three. If all the burners were lighted the gas consumption would be 50 to 60 feet of gas per hour.

This room is 18 x 20, and is brilliantly lighted with three small lamps, one on each cluster. A significant fact in connection with these lamps using open end globes, is that they have been in use over a year, hanging directly over a table constantly covered with a white cloth, and that the table cloth has never been soiled by droppings from the lamps.

CHAMBER.—Fig. 3 shows the ar-

FIG. 4.

rangement for lighting a bed chamber 16 x 20. These lamps are also fitted to existing gas fixtures using suitable adaptors. The center chandelier has four arms and you will note the one in front of the dresser is a two-light fixture.

Two of the lamps on the center fixture are generally used, but when ladies are dressing, the two before the mirror are also lighted, and it can be readily seen that the lighting plan is exceptionally perfect.

LIBRARY.—Fig. 4 shows the library, in a New York City apartment, with four small lamps applied to an ordinary combination fixture. Except in rare instances no more than two of these lamps are used, these making it possible to read comfortably in every part of the room. The rose colored globes used harmonize with the small coverings and window hangings and fill the room with a warm glow which gives a most inviting and homelike tone to the surroundings.

"Holding the Candle."

FROM A CARTOON OF THE XVI. CENTURY.

Home Lighting by Inverted Gas Burners

By T. J. Litle, Jr.

THIS is one of the most complex subjects with which the illuminating engineer has to cope, for he not only has every conceivable condition where special equipment and the proper location of the lamps become necessary, but he also has to exercise great judgment in fixture design and the selection of the proper glassware to harmonize with the interior decoration.

On account of the better downward distribution of light from the inverted gas lamp, and the fact that decorative glassware may be used to better advantage than with the upright burner, I shall limit my remarks to that particular form of light.

The engineer may be perfectly capable of so arranging his lighting units as to give the necessary illumination on a given surface, but unless he possesses some artistic ability, he will not produce pleasing results, which is one of the most important problems dealing with the subject. This means that the source of illumination itself must be considered to a certain degree decorative.

The amount of light required to illuminate a room of given dimensions will vary greatly with the color of the walls, ceiling and furnishings. This should be perfectly obvious.

I have, however, known of cases where objection was raised on account of poor illumination in a room, claiming that the particular lamp used was not working properly, but which in reality was operating just as successfully as the identical lamp of his neighbor, which was giving the very best lighting results.

Now it so happens that in the first case, the walls and ceiling were of dark tint, while in the second case, the room was papered with a light colored paper.

The remedy in such a case would of course be either to repaper the room, using a lighter color scheme, or increase the number of lighting units to overcome the absorption of the dark surroundings.

A very simple experiment to prove this, may be conducted by carrying a lighted candle into a dark cellar and observing the illumination. To the lay mind, the light seems to carry but a very short distance, but what actually happens is that the light is absorbed by the dark, dirty surfaces.

To contrast with this, carry a lighted candle into a cellar which has been freshly white-washed, and you will quickly note the difference. Here it is perfectly possible to see every object in the cellar. This is a case of good reflection and very little absorption.

Generally speaking a lamp should be hung either well above the eye or if hung low, shielded by some form of decorative glassware which will give a relatively low intensity. There are certain cases, however, where it may not be possible to hang the lamps high.

Figure 1, for instance, shows a lighting scheme for a bath room. The lamps are hung low in order that there will be no shadows on the young man's face below his nose, or on the neck, as would be the case if the lamps were hung high.

It is also necessary to have a lamp on each side of the face so that both

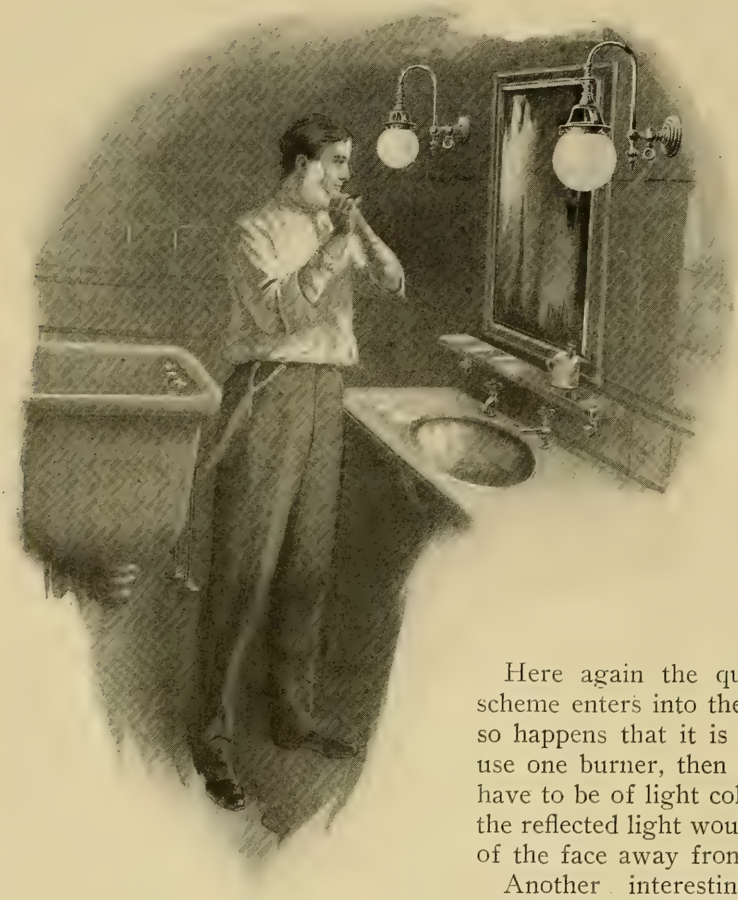


FIG. I.—GOOD LIGHTING FOR A SPECIAL PURPOSE.

sides may be equally lighted. These lamps are equipped with special French rough ball globes in order to cut the intense glare of the mantle. With this particular combination it is possible to shave with greater ease and comfort at night than by daylight.

For instance, nearly all bath-rooms are lighted from a single window which usually is to one side of the mirror, and in this case the side of the face next to the window is of course very much better lighted than the opposite side.

Here again the question of color scheme enters into the problem. If it so happens that it is only possible to use one burner, then the walls would have to be of light color in order that the reflected light would reach the side of the face away from the burner.

Another interesting example of home lighting is Figure 2. The art glass dome here shown is equipped with an inverted burner and is hung at such a height from the table so that those sitting around it cannot see the mantle. This particular fixture is ideal for the dining room or library. In lighting the dining-room table, for instance, it is necessary that the source of light be so shielded as not to enter the eye, but at the same time fall directly upon the table.

This is accomplished by placing the lamp very high in the dome, and the fixture should be hung so that its lower edge is 4 ft. 11 in. from the floor.

By augmenting the downward distribution of light by the use of a prismatic glass reflector an illumina-

FIG. 2.—A GOOD LIGHT FOR DINING-ROOM OR LIBRARY.

As I mentioned before the decorative possibilities with the inverted light are very great. Figure 3 shows a reception hall finished in mission, and in order that the lamp may harmonize with this style of interior decoration, a mission globe is used. It will be noted that the opening in the bottom of this globe is large, allowing a good distribution of light below.

For instance, if a person were to sit on the bench shown at the right of the picture, he could read with perfect ease, and in this connection the advantage of the inverted light is very marked, for if this same globe were used on an upright burner, there would be practically no light thrown below on account of the shadow which is thrown by the brass part of the upright burner.

tion equal to that given by 314 tallow candles is obtained, whereas the inverted mantle without reflector gives only 80 candle-power below. In the dining room, the additional light reflected downward will strike the table cloth and be in turn reflected upward to light the entire room, which is what might be termed direct-indirect lighting, the table being lighted directly from the mantle and reflector, and the room being lighted indirectly from the light reflected by the table cloth.

Here again an interesting experiment may be conducted by simply noting the diminution of the light in the room when the table cloth has been removed. The room then becomes rather gloomy and to the lay mind, the light source itself seems to have decreased.

The lighting of the kitchen is a subject which is often given little or no thought in the average household, but which in reality should be given a great deal of attention.

It is a known fact that in factory or shop, employees work to a better advantage where the room is kept bright and cheerful, and exactly the same holds true in the kitchen of the average household. The kitchen is the home of the servant, and it must be acknowledged that neither the flat flame gas burner nor the ordinary 16-c.p. electric lamp will give sufficient light for good illumination.

The proper way to light a kitchen as shown in Figure 4, is to suspend the lamp high in the room, at the same time using a reflector of wide distribu-

FIG. 3.—HARMONY OF FIXTURES AND FURNISHINGS.

above cut that there are two chains hanging from the burner. These chains operate a self-lighting appliance which makes the inverted gas light just as convenient as the electric lamp, the black button on one chain turning the light out, while the other button lights it. These self-lighting attachments are extremely useful all through the house and form very valuable adjuncts to this system of gas lighting.

While I have dwelt at considerable length upon the various types of equipment necessary in the different rooms, I have not mentioned the fact that special chandeliers have been designed for

tion. In this way the stove, tables, cupboards and sink may be perfectly lighted. I have frequently noticed electric lamps suspended directly over the stove with possibly another lamp over the table. This is decidedly bad, as the grease and smoke from the cooking settle on the lamps, making very frequent cleaning necessary, and where an inverted gas lamp is used, as above stated, the entire room is filled with a flood of light. The work in a kitchen is of a transient nature, which requires a good illumination at almost every point in the room.

It will also be noted in the

FIG. 4.—GOOD LIGHT WHERE IT IS NEEDED.

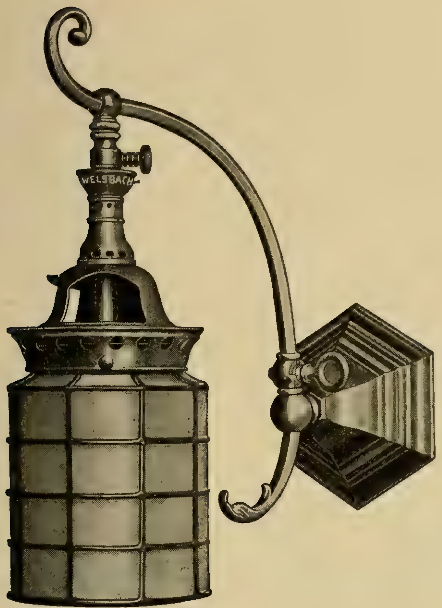


FIG. 5.

the influence of the heat, which of course reflects very little credit upon the inverted system of lighting, the merits of the system are such as to eventually make it supersede all others.

Of late years the mantle manufacturer has been able in his high-grade mantles to produce a light of great intensity and at the same time having a rather soft, mellow tint, which is most pleasing in the home, particularly when contrasted with the cheap, greenish-white mantles which have been placed upon the market and sold principally by house-to-house pedlers.

The strongest point which commends the inverted gas light to the mind of every householder is its marvelous economy as compared with other systems of illumination.

the inverted lamp for general illumination of drawing rooms, reception rooms, parlors, etc. Figures 7 and 8 show these special fixtures and brackets.

A great variety of special glassware has been designed to meet the requirements, not only of artistic decoration but of effective light distribution. (See Figures 9 and 10.)

Generally speaking, the inverted gas light may be considered the ideal artificial illuminant for the home, and while there have been a good many cheap, flimsy burners placed upon the American market carrying common glassware which easily cracks under

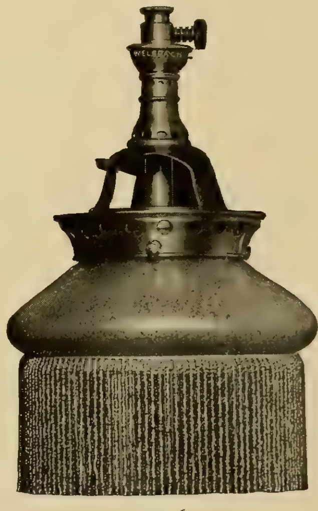


FIG. 6.

Lighting of a Typical New York Boarding House

By H. Thurston Owens.

DESCRIPTIONS of lighting installations which reach us through the transactions of The Illuminating Engineering Society and the technical press deal mostly with hotels, theaters, stores and dwellings of the "very rich." The dwellings of the middle class are rarely described. The descriptions of electric installations are much more numerous than those in which gas is the illuminant, and when members of the gas fraternity prepare papers they describe their offices and not those installations from which the bulk of their income is derived.

The subject of this article is the familiar four-story and basement brownstone dwelling, which has seen better days and of which there are thousands to be found in the city of New York of the type so admirably portrayed in "The Music Master."

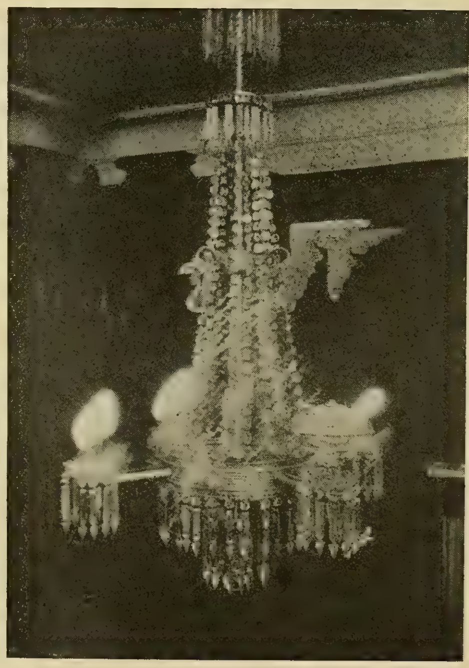
That the former occupants were people of some social pretensions is evidenced by the equipment of the parlor floor, now used as a meeting place for a religious society. The front room is 29 feet by 11 feet 6 inches; the walls are papered yellow, the ceiling white; the lighting installation consists of two crystal six-light chandeliers and one-light bracket; the tips are lava and are 2, 3 and 4 foot. The bracket is on one side of the door leading into the rear room and the outlet for the companion outlet at the opposite side of the door has been capped. The chandeliers are simple in design, of a moderate size and the illumination very pleasing.

The room in the rear of the parlor is used as an office; it is 17 x 17 feet, has dark green papered walls and a white painted ceiling.

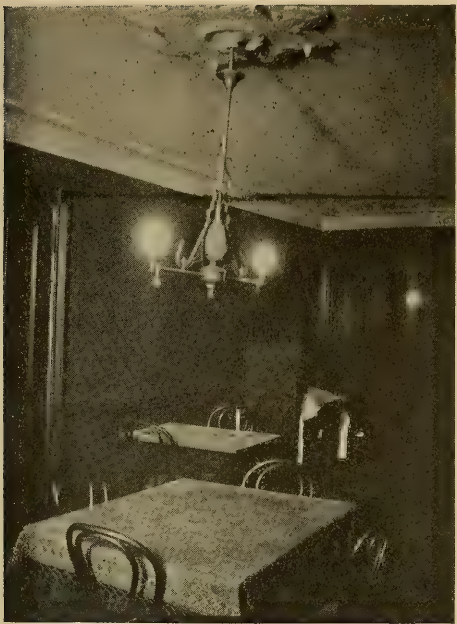
There is one four-light crystal chandelier and four one-light brackets; here the tips are lava 3 and 4 foot.

The crystal chandelier has a "Suvio" heater attached to one of the burners. There are no globes used upon any of the fixtures on this floor and the brackets are rarely used.

In the hall at the main entrance there is a square lantern with clear and colored glass sides equipped with



CHANDELIER IN BACK PARLOR.



DINING-ROOM.

a 2 in. Bray burner, and the effect is a dim, but streaky, "religious" light.

In the hallway upon each floor there is a bracket equipped with a 2 foot "Bray" burner, and clear glass globe. These globes are imitation cut glass and give an inverted class distribution. As the hallways are papered dark green, the installation here may be termed "Beacon lighting."

The dining room is 26 x 11 ft. 6 in.; the walls are wainscoated for four feet in dark wood, the upper portion being papered dark red, the ceiling white. The lighting equipment consists of one chandelier and one bracket, the former having one 4 ft. lava and one 6 ft. aluminum tip, and the latter one 2 in. aluminum.

Should the burners be changed to the mantle type the illumination would be satisfactory, which cannot be said of the present equipment.

The room which should have the best equipment has the worst; it is the kitchen. This room is 17 x 17 feet, with walls of dark green paint and white ceiling; the fixture is of wrought iron (pipe) with two stationary arms, one end being equipped with a 4 ft. lava and the other with pillar but no tip.

The "star" boarders have a room 22 x 11 ft. 6 in., with alcove 12 x 6 ft. and a wash room 9 x 5 ft.; the walls are papered green and the ceiling is white. The equipment consists of one central light chandelier, one bureau bracket and single chandelier in wash room. There are 4 ft. lava tips upon the chandeliers. There is no burner upon the bracket, but it is a convenient place for neckties, razor strops, etc.

The other rooms vary in size and equipment, but in none of them are the results satisfactory.

The Gas Co. will furnish and install tips free of charge, but they will be of the most uneconomical design unless the customer is "wise" enough to ask for "Brays."

"STAR" CHAMBER.

In this particular building the tenants have been unable to obtain satisfactory service from the gas company, and have secured the services of a company who agree to keep all of the burners in proper condition and supply a regulator, the charge being $1.00 per month.

From the existing conditions it looks as though the consumer was between the "devil and the deep sea."

Electricity is more expensive than gas, but America wants the best, and it is most natural that the consumer who is dissatisfied with a miserable gas equipment should think that because he sees good electrical installations that electricity is the only thing.

But the reason is deeper than that —it is unusual for the gas company to help the consumer toward bettering the conditions under which gas is used, while the electric light companies are continually improving their consumers' lighting installation.

Illuminating engineering was started and is being increased in popularity and effectiveness almost entirely through their efforts. By the time it reaches the gas company still further inroads will be made upon their business. However, signs of the times point to better conditions. Lectures upon "Illuminating Engineering" are being given under the auspices of the Board of Education, and the space given to that subject by the technical press will no doubt increase the use of all of our illuminants along the lines which are scientific and therefore economical.

Illuminating Engineering in Mongolia

By G. Wilfred Pearce.

Mr. James Dietrick, M.E., who has conducted large gold mining undertakings in Alaska, Siberia, Mongolia, Thibet and South America, and who is now buying a large amount of electrical apparatus for a Central America gold mine, spoke as follows in this city the other day to a group of engineers:

"There are good openings for a few illuminating engineers in Mongolia, but I would not advise any man who is fond of the comforts of life to go there. I think I am the first man who installed an electric light plant in Mongolia. A 'hoodoo' seemed to be upon that job from beginning to end. In the first place, after I had bought the dynamos, motors, boilers, engines, wire, arc lamps and incandescent lamps, shades and other electrical fittings to the value of $500,000—almost one-third of my purchases were burned on the pier at Hoboken.

"Our first work on getting ashore was to send around the country to buy camels to carry our materials and food supplies away up in the mountains—9,000 to 12,000 feet above sea level.

"We donned native clothing in order not to provoke the hostility of the natives, who look upon a man dressed in the manner of the occident as a fiend. It was a long time before we had gathered enough camels for our train; but at last we assembled three hundred camels and a goodly number of asses, and got off. It appeared from what happened afterward that the story was circulated for hundreds of leagues about that we were a great company of magnificent princes who came from a foreign land with immense stores of bar silver and gold and silken fabrics with which to propitiate 'The Ever Living God,' otherwise the Buddhist Llama, whose temple was not far from the site of the mines to which we were bound.

"This story got out among bands of brigands, and they laid for us in a mountain pass. Our native guards fled at the first onset, but our electrical and mechanical engineers and mechanics, all husky young fellows, put up a rattling good fight with their magazine rifles and killed a lot of the devils. We took sixteen alive and turned them over to the nearest Aide to the Viceroy. He caused each brigand to be first impaled on a sharpened stick, with arms and legs tightly bound. In that position the sixteen were placed in line, and then the executioner cut off their heads with a two-handed sword. I photographed the men, and noticed that for at least two to five minutes after a victim was beheaded the head retained consciousness. One head watched with intense interest the decapitation of two of his comrades.

"After a long time and many hardships we got the plant set up at the mines. Our first illumination with arc and incandescent lamps was a great event in the region. The 'Ever Living God' and three of his Arch Priests came over in great state to see the wonderful lighting. In honor of their arrival our electrician worked up some colored lamps into a decorative effect around a shrine of Buddha. 'The Ever Living God'—worshipped as a divinity by seventeen million people—professed a desire to have such an illumination at a forthcoming great religious festival which every year attracts an enormous number of people from all parts of Mon-

golia and Thibet. The main event of the celebration was a horse race over a course sixty-five miles long, over plains, through narrow mountain passes, up and down mountains, through brooks and rivers, and ending at the gates of the great monastery, which is upward of twenty-five hundred years old. There were five thousand riders in this race, and they drove the horses so hard that more than one thousand animals died on the course. A large loss of human life also occurred through a jamming of the riders in a narrow defile. The annual prize is a whimsical absurdity—the winner has the right to name a woman who for that night alone will be placed as a wife of the 'Ever Living God.' These riders on the occasion when we Americans were there brought at least twelve thousand young women, each hoping that she might be the one to share for one night connubial bliss with the 'Ever Living God.'

"We spread ourselves to the limit in getting up a scheme of electric lighting to honor the 'wedding,' but our efforts went for little that night in pleasing the 'Ever Living God' and his three Arch Priests, inasmuch as one of our party, formerly with the Brooklyn Edison Company, ladled out so much American whiskey to the great dignitaries that they were as drunk as pipers—though their faithful followers declared that they were in a trance.

"One of our party traded a few six-inch opalescent glass globes, which a good friend in New York put in a box of supplies intended for my own bungalow, for much more than their weight in nuggets of gold found in a river bottom. A Chinese official had noticed that the globes were of the color of the highest grade of jade, which the Chinese value higher than any other stones as gems. He coveted the globes very much. I gave them to one of our young men and told him that he might have all he could get for them. Afterward I saw the globes fastened against a wall in the Chinaman's home as ornaments on top of highly decorated coffins which he had made ready for the day when his father and mother should die. The old folks took great pleasure in showing us the coffins as instances of the love and veneration of their son. The old man, a very fine character, had in his younger days seen ex-President Grant, when during his trip to China he was entertained by Li Hung Chang. He had heard of three other Americans—Washington, Edison and John L. Sullivan—and he seemed to think that Edison was the greatest of these, because, as he said through an interpreter, 'He is one of the great conjurers who has made legions of devils stop plaguing mankind and has made them jump first through coal and wood and then into the heated water and then along the wires and then into the lamps and machines, so that they make light and power, though I see that you have to shut them up so that they cannot get out in any way. I watched your works very much, and I see that the devils you imprison in the machines do much more work than the Mongolians that you hire. Great is the empire of Washington and Grant, that makes countless numbers of devils push things along to do work and make light.' "

Theory and Technology

Plain Talks on Illuminating Engineering

By E. L. Elliott.

XIII. Residence Lighting

SOME HINTS TO THE HOUSEHOLDER

ILLUMINATING engineering, like charity, may well begin at home. The comparative simplicity of the problems involved in house lighting especially commends them to the beginner in the profession, while the frequency of bad results and wasteful devices offers plenty of opportunity for the exercise of ingenuity. The average residence does not afford problems on a sufficient scale to be, in themselves, attractive to the engineer from a financial standpoint; but now, when science is just beginning to make a place for itself, a little simple engineering in the home may be the entering wedge in securing a client who has much more extensive problems under his charge. Even a slight change, which is so simple as to seem commonplace to the engineer, may afford an object lesson to the householder that will result in extensive applications of engineering principles elsewhere. The average case of house lighting calls for little mathematical or theoretical work, but rather depends upon good judgment, which is a result of common sense developed by observation and experience, together with an intelligent appreciation of the more essential elements of decorative art.

Unlike some other branches of engineering, illuminating engineering, especially at the present time, has to deal with problems of remodeling and improving installations already in use, perhaps to an even greater extent than the designing of new systems. Such remodeling may involve anything from a mere change of gas tips to the installation of an entirely new outfit of fixtures and accessories. Much can often be accomplished by comparatively simple and inexpensive changes; and as such improvements become appreciated, more extensive and expensive alterations, where justified, will be undertaken without misgivings.

For residence lighting, gas is more largely used at the present time than electricity. Notwithstanding the large extent to which the mantle burner has been introduced, the flat-flame burner is still very common, and is likely to remain so as long as gas companies continue to furnish gas of big illuminating power.

In the older residences the chandeliers were usually equipped with an

old-fashioned slot or fish-tail tip, and some kind of glass globe supported on a four-inch holder. Considering the numerous defects in this type of gas tip, the flickering light produced, the ragged flame, often so irregular as to be destructive of globes, their wastefulness of gas, and the trifling cost of first-class burners, it is unaccountable why they are still so frequently found in use. The best type of burner is that which has a flat tip firmly fixed in the short piece of brass tubing or pillar which screws on to the fixture, and provided with two small orifices, through which the gas issues. These give a flame of regular outline of remarkable steadiness, and more light for a given consumption of gas. In purchasing them, however, care should be taken to note whether the gas pressure on which they are to be used is low or high, as different types of burners are made for different pressures. Metallic tips are quite largely used, and give generally a large, fairly even and steady flame, but are less economical than the two-hole lava tip.

Gas globes are of very doubtful utility, especially those of the cheaper sort. Instead of increasing the useful illumination by throwing additional light below, they project a considerable amount of it on to the ceiling by reflection from the inside of the glass. Furthermore, the holder and neck of the globe are in a position where they intercept a considerable amount of the most useful rays. As a result, the old-fashioned chandelier gives a very poor light underneath, unless a number of jets are burning. The use of reflectors with gas flames is entirely out of the question, since they will crack from the heat if made of glass, and in any case will soon become so smoked as to be of little use. The only accessory that will accomplish the purpose is a Holophane globe, but when these are used particular care must be taken to use tips giving a perfectly regular and not too large flame, otherwise the breakage will be excessive. Such globes throw down a considerable portion of light, and also diffuse it over their whole surface. The only real excuse for the traditional glass globe is its effective appearance, and in the case of many of the designs the excuse was a mighty poor one. On modern fixtures, even of the most elaborate design, the globe is omitted entirely, and the bare gas jet is used issuing from an imitation candle, an arrangement which cannot be greatly improved upon for practical results. Gas flames are not of sufficiently high intrinsic brilliancy to absolutely require a diffusing globe when used for purposes of general illumination, and a symmetrical and steady flame is in itself an attractive object.

In spite of the far greater economy and more brilliant illumination obtainable from mantle burners, there are still cases in which the flame burner is preferable. These include positions where light is infrequently used, or used only for very short periods of time, or where only a small amount of light is required. In such positions, the greater ease with which the gas can be lighted, and the avoidance of keeping mantle and chimney in good condition will more than offset economy in the amount of gas burned. In some of these positions very much smaller tips can be used than the regular size. It is far better to use a small tip, where only a small amount of light is required, than to use a larger tip partly turned off, as in the latter case the smoke flame often results. A one-foot tip will give all the light necessary for ordinary use in hallways, bathrooms and the like, and

may be left burning continuously without any misgivings as to extravagance, since at the ordinary price of gas it will only burn 2½ cents worth in a full day of 24 hours.

To give explanations as to how to turn gas on or off may seem nonsensical, but how often is a gas jet which has been turned on, turned entirely out when it was intended to turn it on. This trick of turning a gas jet off when it should be turned up seems to be a peculiar idiosyncrasy of womankind, and is proof positive that as a class they are not fit for great feats of engineering. We therefore venture to give the simple directions necessary to avoid such mishaps. A gas cock is always so made that when the thumb piece or handle is turned parallel to the gas pipe the gas is on, and when turned directly across the pipe the gas is off. It is also furnished with a stop which prevents the handle from being turned past these positions. Suppose now the handle is turned obliquely to the gas pipe, which will be its position when the gas is partly turned off. To turn up the gas, therefore, it must be brought into a position in line with the pipe, which can be done by turning the ends of the handle toward the pipe, *i. e.*, by turning it through the smallest angle that will bring it in line. Conversely, to turn it off, the two ends must be turned toward the pipe, or through the smallest angle that will bring them crosswise.

Notwithstanding the fact that the mantle burner has been in use for more than a quarter of a century, and its vast superiority in point of economy, steadiness and brilliancy of light fully recognized, its use is practically never anticipated in installing the equipment for residence lighting. The same old type of chandelier, with from three to six arms carrying ordinary gas tips, still holds its place. When the need for better lighting makes itself felt to the extent of purchasing mantle burners, a single burner is placed on the chandelier; and as this is found to give ample light—in fact, much more than was obtained by the use of all the flame burners together—the remaining tips are left in place, thus giving a very unbalanced and makeshift appearance to the fixture.

There are two ways around this difficulty: either equip the fixture throughout with the regular size burner, keeping those not in regular use in reserve—which is not a bad idea, considering that an accident in the way of broken mantle or globe cannot be immediately repaired, on account of the parts being too hot to handle—or use a smaller size burner, and keep them all burning. Small mantle burners, using but one foot of gas per hour, can be had in several designs, among them a form which is an almost exact imitation of an electric lamp socket. These small burners give somewhat more light than the ordinary size electric lamp bulb, and are especially adapted to decorative treatment. Three of these burners can be used on the same amount of gas taken by one of the regular size mantle burners, and five of them on what the ordinary flame tip uses. The use of the full complement of such burners on a chandelier is therefore no extravagance.

The inverted mantle burner is a comparatively recent importation from Europe, and has made a prominent place for itself in this country. They probably give a slightly higher efficiency than the familiar upright burner, but their chief merit lies in the fact that they give a large part of their light in a downward direction, and that they are naturally more decorative in

appearance. Owing to their construction, however, they give a very much more unbalanced appearance to a chandelier when used on only one of the arms than the upright form. In new installations, where the chandelier can be designed for the special use of inverted burners, they would undoubtedly be chosen for both economy and beauty. It should be understood, however, that the upright burner is also capable of very artistic treatment, and that by the use of the proper accessories its light can also be thrown down.

The mantle gas burner is so highly efficient, and gives such a large volume of light, that there is no excuse for not using a good diffusing globe. Opal glass sufficiently dense to completely hide the mantle, or heavily "frosted" glass, will prevent that effect of "hardness" which is erroneously thought to be a fault of this light.

By replacing flame burners with properly selected mantle burners in all cases where general illumination is required; by using the best form of tip, of the right size and properly adjusted to pressure, in places where only occasional or a small amount of light is required; and by a judicious selection of globes and shades, the illumination can be brought to a satisfactory condition, and gas bills in many cases more than cut in half. All this can be

A DINING-ROOM CHANDELIER DESIGNED FOR BOTH SPECIAL AND GENERAL ILLUMINATION.

It accomplishes its purpose as to lighting the room and table, but is awkward and inartistic.

done without the use of highly technical engineering, but merely by a little investigation and study of the subject, and as such information the gas company will generally be very glad to supply.

In the majority of cases in which electric light is provided, it is in combination with gas, *i. e.*, combination fixtures are installed. Since gas jets must have an upright position, it is more usual to find the electric lamps turned downward, either vertically or at an angle; although in many cases, especially where the fixtures have some pretension to elegance, the electric lamps are in an upright position also. If the electric lamps hang downward, practically the only question to be considered is that of the globe or shade to be used. These are so varied in design and effect on the light that it would be out of the question to deal with individual specimens; the various types, however, are not so numerous, and some general facts regarding them may be useful.

Globes of frosted or etched designs soften the light with a loss of from 10 to 30 per cent.; those of milky or opalescent glass will absorb anywhere from 10 to 75 per cent., according to the density and color of the glass. Those of cut glass, or pressed glass in imitation of cut glass, will absorb from 25 to 50 per cent. of the light, and give very poor diffusion, breaking the light up into more or less bright spots, rather than spreading it over the surface of the globe. Holophane globes increase the light below, and scatter the light in very small spots over their entire surface. Prismatic reflectors throw a large amount of the light below, and allow enough to pass through to give all the light required on the ceiling. Frosted lamps absorb about 15 per cent. of the light to begin with, and rapidly increase this absorption to 30 per cent., or even 50 per cent. When a lamp is used in an open globe it may be frosted over the end, so as to hide the filament entirely when placed in the globe, which is not so wasteful as frosting the entire lamp.

In all cases either a diffusing globe or a frosted bulb should be used; for even though the actual amount of light is cut down somewhat, the effect on the eyes is so much better as to fully justify this loss.

In case the electric lamps are placed in an upright position, and especially where a saucer or disk of metal is placed under them for the ostensible purpose of harmonizing them with the "candle" gas jets, there is shadow directly underneath the fixture and bright light on the ceiling above. If the ceiling is white, and the room is used only as a sitting room or parlor, the result is a sort of indirect lighting which is not bad, provided the lamps have diffusing shades. Of course, it is less economical than direct lighting from lamps installed in a downward position, and is entirely unsuitable for libraries or dining-rooms unless special reading or table lamps are used in addition. In some cases the arms of a chandelier can be reversed by bending or turning around on the fixture without disturbing the wiring or interfering with the design.

A large dome or shade, covering usually from three to five lamps, is a very common kind of fixture in the newer installations in dining-rooms and libraries. They are usually constructed of stained glass or colored silk, both of which give very little reflection, and are highly absorptive. While such an arrangement is artistic and correct in general principle, the use of several lamps is an unnecessary waste. Wherever possible, such clus-

COMBINATION GAS AND ELECTRIC LIGHTING OF A HALL.

The two electric bowl fixtures are artistic and effective. The brackets should have been placed between the doors, instead of on the casing. The small bracket should have had a small imitation electric mantle burner instead of the candle.

ters should be replaced with a single lamp hanging vertically downward, and fitted with a prismatic glass reflector. Both reflector and lamp should be placed as high up in the shade as possible, so that the lamp will not come directly in view when in use.

As in the case of gas lighting, lamps smaller than the usual size can frequently be used to advantage. There is not in this case, however, quite as large proportional saving, as the smaller lamps take more current in proportion to the light given. 8 candle-power lamps, however, are nearly as efficient as the 16 c.p. It gives a very much better appearance to a chandelier to have all lights burning, which can be done with the same amount of current by using smaller lamps. Electric lamps known in the trade as "Hylo," or "Turndown," are exceedingly convenient for a number of purposes. These lamps contain a small, or "baby" filament, giving about one candle power, besides the ordinary size filament, with a switching device by which either filament can be lighted. The small filament often does not take enough current to even start an electric meter, and in any case its consumption is a mere trifle. Many people are accustomed to have a little light in a sleeping room all night, and for this purpose the turndown lamp

is a perfection. Hallways and bathrooms, where it is convenient to have a little light throughout the night, are also locations in which it can be properly employed.

Lamps deteriorate in use, and should be rejected when they become blackened, or when in comparison with a new lamp they look red.

In the case of new installations, the location of the fixtures and their general design can be arranged with due regard for both illuminating results and artistic or decorative effects. As to the illuminant to use, if gas and electricity are both to be had, by all means provide for the use of both. Such a provision is a safeguard in case of possible accident to either supply. Electricity has the advantage of producing far less heat, and of being turned off and on with greater convenience, while gas is cheaper. It is entirely a question of personal choice between these relative advantages and disadvantages. Where both are installed the advantages of each would be gained by using gas in the winter, when the additional heat is of advantage, and electricity in the summer, when the heat from gas lighting is sometimes burdensome.

The general arrangement of lighting fixtures involves a choice between chandeliers, ceiling lights, and side brackets. As a general rule the chandelier centrally placed, or in case of rooms considerably longer than broad, of two or more chandeliers symmetrically placed, is a preferable arrangement for general-purpose rooms, such as parlors, reception rooms, music rooms, and general living rooms. It is usually better to place the electric lamps in a downward position, and the chandelier well up from the floor. If it is the intention to use electric light as the regular source of illumination and gas as a substitute, the simple imitation candle gas burner will answer every purpose. On the other hand, if gas is to be used as the principle light-source, it would be better to have the chandelier designed for the use of inverted mantle burners. A ceiling fixture in the form of a bowl or other decorative design may take the place of a chandelier in rooms with low ceilings. Where the ceilings are of fairly good height, however, the chandelier is preferable, both as regards decorative effect and illuminating results. Side brackets are much less efficient than chandeliers, since practically half their light shines upon the wall to which they are attached; and only the reflected rays are effective in producing general illumination. Furthermore, when used for lighting a room, it is impossible to look in any direction without the eye encountering one or more sources of light. Special care should therefore be taken to soften or diffuse the light when side brackets are used.

In rooms requiring special light, such as dining rooms and libraries, the fixture already referred to, consisting of a large dome, or umbrella-like shade of silk, suspended over the table, is unquestionably the best arrangement. Such a fixture may contain a single upright mantle gas burner, or a single electric lamp, of 32 candle-power if brilliant illumination is required. The one precaution to be taken is to see that the light can spread far enough underneath to cover the space desired, that is, the table and the surrounding space within reach of those sitting about it, but that the light-sources themselves cannot be seen. This is a simple matter of adjusting the height of the fixture and the position of the lamp within. Where such fixtures are used, some

light for general illumination is usually required. This can be furnished sometimes by portables on the mantle; at other times by side brackets. A cluster of lamps on the ceiling around the point of attachment of the fixture is also sometimes used, but this is far less decorative than the other methods mentioned.

Long halls are preferably lighted with side brackets, which do not obstruct the general view, and bring out the perspective. Square entrance halls have a central lighting fixture, some form of lantern being popular for this purpose, although strictly speaking, lanterns are only suited for out-door use. A ceiling bowl, where electricity is used, is a very satisfactory method of lighting such a hall, since it gives an unobstructed view in all directions.

In smaller sized bedrooms brackets placed so that a mirror can be placed between them are the best arrangement. In larger bedrooms a central chandelier may be added for general illumination. In every case provision should be made for lights on both sides of the mirror, and also a light at the head of the bed. This latter may be a permanent side bracket, or a portable lamp supplied from a plug outlet where electricity is used.

A COMMON CASE OF MAKE-SHIFT ELECTRIC LIGHTING.

Note the flexible cord strung from one room to another. A bare 16 c.p. electric lamp is also dropped from the chandelier.

Curves for the Calculation of Foot Candles

By C. W. Kinney.

The writer has developed the accompanying curves for use in the quick solution of lighting problems in which the lighting depends upon one or two sources.

The known quantities are as a rule: the candle-power curve of the source of light, giving the candle-power at various angles; the vertical light of the source of light above the plane in which the point to be lighted lies, and the horizontal distance of this point from a point directly under the light, and in the same plane. Assuming the problem of a hanging lamp.

With these "known quantities" in mind the curves are plotted with reference to the horizontal distance. The values in the curves are the reciprocals of the squares of the actual distance from the source; for example, "Curve 2" represents the reciprocals of the squares of the distances from the source of light of points in a plane two feet below the light and at given horizontal distance from a point in the plane and directly under the light.

"Curve 4" is plotted the same way for a plane four feet below the source of light, etc.

The "vertical distance" and "horizontal distance" intersections give the angle for reference to the candle-power curve when dotted lines are referred to.

Example: It is required to light a point in a plane four feet below the source and at a horizontal distance of six feet, the intensity to be one foot-candle.

Solution: follow horizontal distance to 6 foot line, follow down 6 foot line to "curve 4," read this intersection in per cent. column, 1.9 per cent. Find intersection of 6 foot horizontal and 4 foot vertical lines, refer to degree (dotted) lines, about 56 degrees.

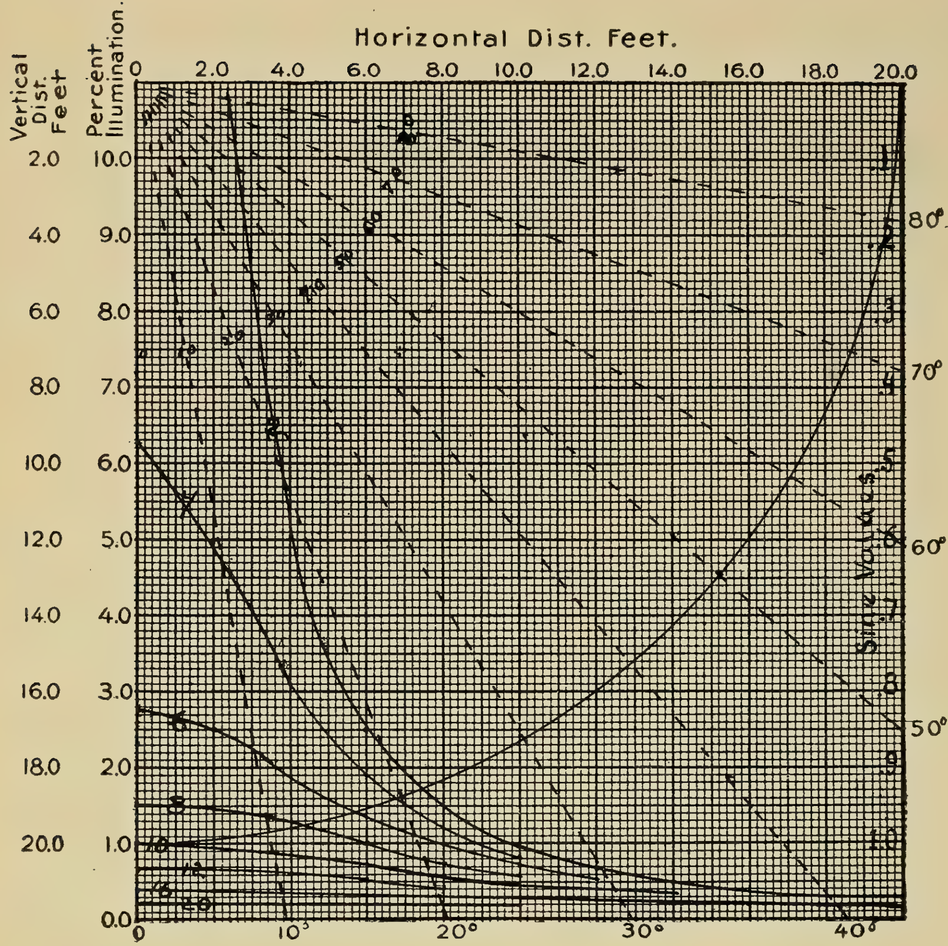
Now, the value of the intensity in foot-candles is equal to 1.9 per cent. of the value of the candle-power of the source. Therefore, the candle-power of the source must be a quantity equal to the value (in foot candles), of the lighting required divided by 1.9 per cent.: *i. e.,* $1 \div 0.019 = 52$. Thus the source must have a candle-power equal to 52 along the 56 degree line.

Inversely, if the candle-power of the source is 52 along the 56 degree line, the illumination at a point six feet out from the lamp and four feet below will be $52 \times 0.019 = 1$ foot candle.

Curves are plotted for planes two feet, four feet, six feet, etc., below the source. For intermediate planes the position of the curves are easily estimated.

These curves take into consideration the distance only. They have been found very satisfactory for store and factory lighting. For office lighting a similar set of curves have been plotted, the values of which take into consideration the sine of the angle of incidence with the horizontal. For this work, however, it has been found advisable, owing to the various inclines of desks, etc., to use the curves as given, and multiply the results by the sine of each angle as it appears.

The accompanying curve together with a set of "candle-power curves" that are easily obtained from manufacturers and mounted on cards make a very handy set for a large number of solutions of lighting problems.



Instead of using a table of natural sines for obtaining the sine values, the following simple method may be used:

Draw a quadrant of a circle with a radius of ten divisions of the paper; as shown on the above diagram. Number the divisions from 1.0 to .0; beginning at the bottom. To find the sine of a given angle, proceed as follows: draw a line at the given angle to met the quadrant; from this point of intersection follow the nearest horizontal line of the paper to the right hand margin, and read the value from the scale. This will give a value of two decimal places, which will suffice for the purpose in hand.

Studies of Notable Installations

The Color Press Room of the Curtis Publishing Co., Phil'a.

Color-printing has become an indispensable part of even the most modest printing office, and a very important and essential part of the large establishments in which modern magazines and periodicals are produced. By color printing is not to be understood the simple printing of different letters in different colors, but the blending of one color with another, on the principle of the "three-color process," which produces results of astonishing faithfulness to copy. Instead of three colors, two are often used, and occasionally four. The final result obtained, as can be readily understood, will depend upon the nicety and uniformity with which the different colors are blended. The colors used are strong pigments, red, yellow and blue being used in the three-color process, with black occasionally added for additional strength in shadows. From these positive colors all the delicate tints and degrees of light and shade are produced by the printing of one color over another with photo-engraved plates. The slightest difference in the amount of ink distributed over the plates, or the degree of impression given to the paper, is sufficient to change the color, and, therefore, the whole effect.

Before the run is made, proofs are worked up which serve as standards. These are given to the pressmen as guides for the regular edition, and it is up to them to see that the last sheet off is practically indistinguishable in general effect from the standard proof sheet. This requires constant watching and comparison of the proof with the sheets delivered. It is a case of matching up tints and colors which can scarcely be excelled in the exactness of its demands. Since much of the work must be done at night, or by artificial light, the question of providing a light which will give practical daylight values for these comparisons is apparent. The installation, a view of which is shown in Figure 1, is unique in its method of lighting. The light is furnished by specially designed enclosed arc lamps. These are of such construction that they operate in an inverted position, *i. e.*, the regulating mechanism is below the carbons, and the lower carbon is made the positive one, in order to throw the light upward. The mechanism of the lamp is shown in Figure 2.

The arrangement of the case and reflectors is shown in Fig. 1. The latter are of metal; the lower one conical and the upper one spherical. Both are

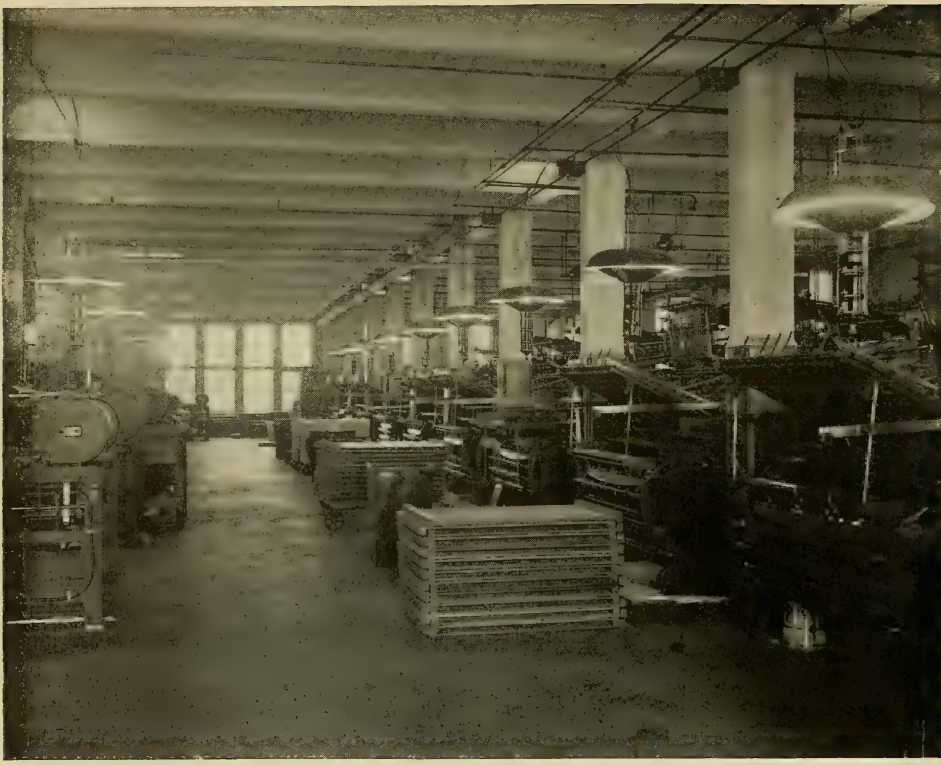


FIG. I.—COLOR PRESS ROOM, CURTIS PUBLISHING CO.

given a white coating on the inner surface. It will be noted that only an annular space is left between the two reflectors, from which the light is distributed. This is for the purpose of confining the light entirely to the table provided for comparing the proof and the regular run of sheets, and protecting the eyes against direct rays from the arc. The general illumination of the room is by an entirely separate installation of arc and incandescent lamps. By careful experiments the exact quality of the white coating necessary to give the daylight values was determined. It is a well-known, though less familiar fact, that reflecting

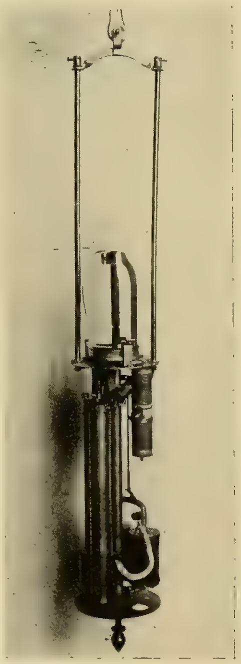


FIG. 2.

surfaces have a selective absorption, as well as transmitting substances. All surfaces that are white to the eye are not by any means white by spectrum analysis. The practical results obtained in this installation are satisfactory to the highest degree. The foremen and pressmen assert that they can match up colors and keep their run uniform as well by the light of these arc lamps as by daylight.

The general design of the lamp, and the special construction of reflectors for this purpose are due to Mr. C. J. Terring, who is one of the veterans in the arc lamp field.

Editorial

BY
E. LEAVENWORTH ELLIOTT

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As to the Future of Gas Lighting

AT the meeting of the Philadelphia Section of the Illuminating Engineering Society, held November 15th, an unusually comprehensive and instructive paper on Inverted Gas Lighting was presented by Mr. Whittaker. In announcing that the paper was open for discussion the Chairman expressed a wish that the discussion might be a lively one, and from the stenographic report it appears that his wish was fully complied with. In the course of the discussion Mr. W. H. Gartley said:—

"I have a publication here known as THE ILLUMINATING ENGINEER, a journal purporting to deal with the literature of artificial illumination, and it seems to me that it is proper to make a criticism at a regular meeting of this association on an editorial that has appeared in the October number.

"This journal, while it has no official connection with our association, has made an appeal to the members as having a common interest with the purposes of our society, and has a large number of our members on its list of subscribers. I will not read the entire article, but will simply abstract." (Mr. Gartley then abstracted this editorial very freely, beginning with the statement that "Unquestionably gas lighting is being driven to the wall in this country by electric lighting.")

"This makes interesting reading after you have listened to the description by Mr. Whittaker of the successful efforts to place upon the market a burner that is so efficient and extremely popular. It is difficult to understand how such an article could appear in any journal, however ignorant the editor may have been of general affairs. It is more difficult when we consider that the editor assumes to write with authority upon this particular subject. It may be that the editor wrote it from a mistaken but Spartan purpose of 'hewing to the line,' but from a considerable experience I feel open to the conviction that it may have resulted from the blind fury of a person who was at variance with the gas company as to the amount of his last gas bill. I leave to your contemplation the business sagacity of a journal that will thus relegate to senility, absolutely without foundation, a business in which a large number of its subscribers are engaged happily and successfully."

We will take up the several counts in this indictment *seriatim.*

Mr. Gartley begins by expressing his appreciation of the successful efforts of the Welsbach Company to

place an extremely efficient and popular burner upon the market. The editorial referred to states:—

"The manufacturers of gas burners and accessories are not in the least to blame for this decadence in the use of gas lighting. The incandescent electric lamp, which has been the backbone of the electric lighting industry, and the Welsbach gas burner, were introduced simultaneously; and in the twenty-five years since their introduction, the improvements in gas burners and mantles have at least kept pace with the improvements that have been made in the electric lamp."

Had it not been for the revolutionary discoveries of Dr. Auer von Welsbach, and the vigorous and progressive policy of the companies which took in hand the commercial exploitation of his invention, gas lighting to-day would be what we predicted it may come to in the future, a mere "snapper-up of unconsidered trifles" left by the electric lighting interests.

As to our "ignorance" and "authority," we do not pretend to omniscience, but our sources of information on this particular subject are fairly comprehensive. THE ILLUMINATING ENGINEER, through its representatives, has come in personal contact with every gas company of prominence, and most of the less important ones, from Maine to Denver, and with all of the others by correspondence. Such a personal canvass ought to afford a fair basis of judging the general attitude of the gas companies at the present time toward modern illumination. As a result of this poll we state without fear of successful contradiction that the number of gas companies who are really pushing gas lighting on up-to-date methods, such as are being used by the majority of central stations, is such a small minority that they can only be properly recorded in the total vote as "scattering." Since the editorial was written we have learned that one of the representative gas companies of the country has inaugurated a thoroughly progressive policy of this kind, in charge of an unusually competent and successful "new business" manager. This will afford the opportunity, for which we expressed an earnest hope, of demonstrating what can really be done to maintain the prestige of gas lighting by keeping abreast of the procession in the theory and practice of illumination.

We wish to assure Mr. Gartley that, so far as bills are concerned, we are at peace with the entire gas world. In our home we use the good old-fashioned kerosene lamp, for the very sufficient reason that there is neither gas nor electricity available. It is *apropos* of the question, however, to observe that in our offices there are ample outlets for electric lamps in every room, and but two outlets for gas, which are capped,—a wholly unnecessary precaution in view of the fact that there is no gas in the pipes. The building is modern.

It is putting it a little strong to say that we have "relegated the gas business to senility." It was gas *lighting* of which we were speaking. The future of the gas industry in supplying sources of heat and power is exceedingly rich in promise; in fact, in these two great lines it is only in its infancy, and is bound to develop to vast proportions.

We are pleased to be assured, however, that a large number of our subscribers are "happily and successfully engaged." It is no small comfort to know that THE ILLUMINATING ENGINEER is contributing in any degree to the cheerfulness of the world.

Mr. Gartley further says:—

"I deny absolutely that the gas business is going into decadence. There has been here and there a municipality that has undertaken to mix politics and business by

operating a gas plant, and the result has been in every case disappointing; but the same is true of the electric lighting industry. I do not wish to be considered as presenting an argument why the gas companies have failed to keep up with the procession by reason of the fact of their failure to hire the proper kind of talent. A becoming spirit of self-effacement of the pride that the gas engineers at large in this country take in the success of their work would not permit me to deal with the latter part of this proposition, so I will simply deny the fact on the broad ground that the gas companies are not by any means falling behind in the procession. They are not content to take up only such scraps of business as are left behind them by the electric lighting companies. Could anything be more absurd than such a statement? Here in Philadelphia—I cite this because you are all acquainted with it—the electric lighting company, judging from the beautiful building in which we are guests tonight, has met with a fair measure of success; but at the same time, let me say that the gas company is now selling, for illuminating purposes alone, nearly twice as much gas as was sold for all purposes ten years ago, and it may not have escaped the attention of you gentlemen that the uses of gas for purposes other than lighting have advanced briskly."

In regard to the gas company picking up only such scraps of business as are left them by the electric lighting companies, Mr. Gartley simply misinterprets our statement. What we said is that "Unless better generalship is shown by the gas interests, so far as lighting is concerned, they are destined to dwindle into a mere hoard of camp followers, picking up such discarded bits of lighting as the electrical interests may see fit to leave in their trail." What we intended was to sound a note of warning, rather than to imply that gas lighting at the present time was in a state of absolute decadence.

The statement that the gas company in Philadelphia is to-day selling for illuminating purposes alone nearly twice as much gas as was sold for all purposes ten years ago, is an interesting bit of statistics. On this point we wish to observe that Philadelphia is not only the home city of the parent Welsbach Company, but has always had an especially progressive and efficient local Welsbach Company; and in a recent visit to the city, we were very favorably impressed with the extent to which incandescent gas lighting is holding its own. Furthermore, the city has increased its population in the past ten years to a considerable extent; and still further, the use of artificial light of all kinds has enormously increased per capita within this period: all of which facts have some bearing upon the increase in the sale of gas mentioned.

Mr. Gartley further says:—

"There can no good come to The Illuminating Engineering Society by this effort to deprecate one of the co-related industries. Such a spirit of antagonism is going to provoke into a flame a feeling that will consume the future of the association. We are to study the question of how to adapt the uses of our light-giving materials, to bring out their greatest efficiency and satisfaction to the consumers. There is no intelligent exponent of gas lighting who will readily admit that there are demands for illumination that can be better served by electricity than by gas, and you will find that while making this admission all of them reserve to themselves the pleasant knowledge that there is a vast number of places where, for various and absolutely rigid reasons, gas lighting must and will prevail."

Here, again, Mr. Gartley entirely misinterprets our meaning. Nothing could be further from our intention than to antagonize gas lighting; on the contrary, we have repeatedly stated, not only in these pages, but in contributions to other periodicals, that in point of illuminating results gas light could be made in every way the equal of electric light; and it was rather a feeling of regret, on observing

that this venerable light-source, which possesses so many inherent good qualities, was in danger of dying of inanition, that prompted the editorial in question.

Concluding Mr. Gartley says:—

"A better spirit—one more useful to this association—would be engendered if we agree that the demand for artificial lighting covers such a large field that *there is plenty of room for both industries.*"

The italics are ours: to which sentiment we say, Amen.

At the close of Mr. Gartley's remarks the Chairman said:

"It occurs to me that there may possibly be one or two other reasons for this contribution to lighting literature. Possibly the writer thinks that if the gas companies are not employing illuminating engineers, they ought to employ the illuminating engineer who wrote the article, or perhaps he thinks we ought to patronize the "crowd" a little more. *Or, this might have been written in a spirit of criticism to get us going a little and stir up the illuminating engineers.*"

We can appreciate the humor of the Chairman's facetiousness, even though the joke is on ourselves, especially since his closing statement, which we have italicised shows that he really grasped the true inwardness of our purpose.

In some brief remarks Mr. Forstall said:

"In regard to the article referred to by Mr. Gartley, I thought when I read it that if its statements were true, then I as a gas engineer, ought to belong to a cooking class, rather than to an illuminating engineering society."

To use an old expression: there is "more truth than poetry" in this statement. In conversation with a representative of a prominent gas company at the meeting of the Gas Institute, he set forth the situation substantially as follows: "The manufacture of gas stoves in recent years has proven to be a very profitable industry; and the manufacturers have labored early and late, both with the gas companies and the public, in pushing their wares upon the market. This has resulted in diverting almost the entire energies of the gas companies in the direction of supplying gas for cooking, to the relative neglect of gas lighting. Now that the public are fairly educated to the advantages of using gas for cooking purposes, it is time that the lighting end were taken up and pushed with greater vigor and progressiveness."

In conclusion, we will attempt to more clearly state the position of The Illuminating Engineer as to gas lighting:

In quality of illumination, including color, ease and comfort to the eyes, facility in distribution, and general utility, gas light is the peer of any illuminant at the present time.

With the exception of elaborate and expensive installations, modern gas burners are susceptible of as artistic effects as electric lamps.

Its relative cheapness is a full offset to the somewhat greater convenience and less proportion of heat of the electric lamp.

The manufacturers of gas lighting apparatus have kept abreast of progress to an extent unsurpassed by the manufacturers of electric lamps.

The fixture manufacturers have devoted what energies they have in the way of progress entirely to electric lighting, leaving gas lighting in the condition which it has existed for the past 100 years.

The gas companies have made almost no effort toward educating the public in regard to modern methods and possibilities of gas lighting; and in view of the systematic and vigorous efforts of the electric interests in this particular regard, gas lighting is being superseded by electric light to an extent entirely incommensurate with the relative advantages and disadvantages of the two illuminants.

The Commercial Aspect of the New High Efficiency Electric Lamps

Since the appearance of the tantalum lamp in commercial quantities some two years ago, the announcement of methods of constructing filaments of even higher efficiency have been frequent. As the various reports have necessarily had to deal with scientific terms that were new to the general public, the whole matter has been developed in more or less mystery. The situation, however, is not at all difficult to analyze. In order to attain a high efficiency, *i. e.*, a greater amount of light for a given amount of current, than is possible with the carbon filament lamp, the life or durability of the lamps being equal, it is only necessary to find a substance for the filament which will withstand a higher temperature. It is one of the common facts of chemistry that there are a series of elements of a metallic nature which have extremely high melting points; and as it is the melting point which limits the temperature to which any filament substances can be raised, these so-called infusible metals fulfil this condition.

These metals, however, have two very serious faults for this purpose, namely, brittleness, and comparatively low resistance. The latter defect materially increases the difficulties of overcoming the former, for low resistance means either a longer or a finer filament, both of which facilitate mechanical breakage. The problem of overcoming these defects has been attacked from all sides. In the case of tantalum, which had always been considered a non-ductile metal, the difficulty was met by the discovery that its brittleness was due to certain impurities; and the working out of a practical method of purifying the metal so that it could be drawn into an exceedingly fine wire, placed it on a practical basis.

In the case of the other metals, three principal methods have been used to overcome these difficulties: First, alloying; second, combining the metals in the state of a fine powder with some substance as a binder; third, using a chemical combination of the metals, such as the carbides. Patents based upon all three methods have been taken out by different inventors, both in Europe and in this country.

In a field so broad and so little investigated by previous scientists, it is surprising that the various methods have been brought to some degree of commercial success within the short space of two years.

That filament material made by any of these processes is capable of developing a much higher efficiency than carbon there can be no doubt, from the numerous laboratory reports that have been published. In the astonishment at the revolutionary results obtained in this regard, the fact must not be lost sight of that practicability is even a more important consideration than efficiency. The carbon filament incandescent lamp is perhaps the most nearly perfect device, in point of simplicity, that has ever been put into the hands of the public. It is as near being "fool proof" as anything made by human hands can well be; and it is this simplicity that has raised electric lighting, within a period of 30 years, from a scientific curiosity to a place in the foremost line of luminants. However, we may admire the one-watt lamp as a scientific achievement, until we can go to our dealer, or lighting company, buy such a lamp at a reasonable price, carry it home in our pocket, and place it in service without danger of injury or breakage, our admiration will not lead us to discard

the "old reliable" carbon filament lamp.

It is a characteristic American trait to avoid troublesome details and care in small things. The saving of half or even two-thirds of the bill for electric current would not compensate the average American for an increase in care and attention necessary with a new form of lamp. In very large installations, where it would pay to employ a special engineer or attendant to keep it in shape, the case would be somewhat different; but even then, its commercial success would be very dubious. The care required in the transportation of some of the new high efficiency lamps, and the size of the package, the nature of packing, etc., used, are simply grotesque.

That the carbon filament is bound to be supplanted in the not distant future, the progress made within the last few years gives little room for doubt; but the lamp that finally does the supplanting will be a lamp comparable with it in point of simplicity and mechanical strength. A 2 or even 2½ watt lamp that would compare in practicability and price with the present carbon filament lamp would at once find a mark that would tax the capacity of any American lamp factory to fill. Of course, if higher efficiency can be obtained without loss of practicability, so much the better. The reports of work done along this line so far give very strong grounds for hope that such a solution of the problem will be made in the near future.

In order to give our readers who are interested in the scientific aspects of new lamp development a comprehensive view of the situation, we are re-publishing a very exhaustive and carefully written article by Dr. C. Richard Boehm, originally contributed to the *Chemiker Zeitung*. A portion of the article appears in this issue.

The Panic

The country has recently experienced a financial panic. The word "Panic," in its original sense, is peculiarly expressive of the situation. In ancient Greece, it occasionally happened that soldiers in battle, for no sufficient or apparent reason were suddenly seized with uncontrollable fright, thus rendering them unfit for duty, and often resulting in their utter rout. If such a thing were to happen in this country it would probably be blamed on the administration, but the Greeks attributed it to the spite of partisanship of the god Pan; hence the word "Panic," which may be briefly defined as senseless fright.

The origin of the term fits exactly what has just been happening in the business and financial world. Everybody agrees that the material conditions of prosperity are as numerous and as sound in the country to-day as they were two months ago. When reduced to the last analysis, the country is just as rich. There has been no destruction of any material wealth. Certain individuals, engaged in huge speculative enterprises, "bit off more than they could chew," as the expression goes, and when they began to choke those immediately connected with them were seized with uncontrollable fear, which, once broken loose, spread with its customary rapidity—first in New York, the financial center, and then throughout the rest of the country.

The panic-stricken soldier was afraid for his life, and sought safety in flight. In the present case it was not loss of life but loss of money that was feared. Money, therefore, was hurried into places of concealment with all possible speed. Those who have been so precipitate in withdraw-

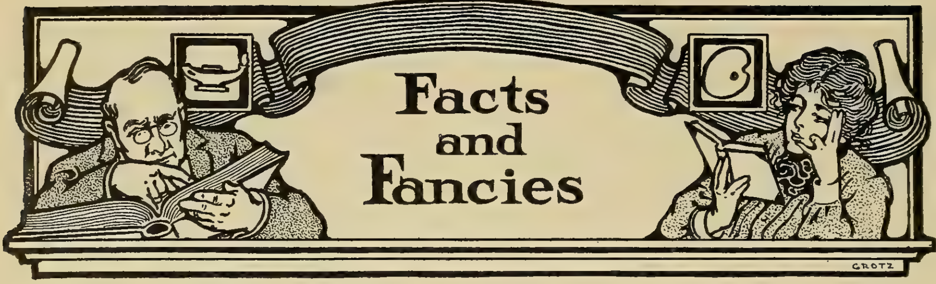
ing their money from its legitimate place in the channels of commerce, could not, if called upon, give any more definite reason for their action, nor explain why they are afraid, nor what they are afraid of, than could the child who suddenly wakes in the night in terror of some imaginary danger explain his fear.

There has been, and is at the present time, a large demand for the products of the farm, the mines and the factories. The only condition necessary for business to assume its customary activity is for the people to shake off this fear, which has absolutely no basis in fact.

It is a psychological fact, however, that the mind once terrified requires more or less time to attain its normal composure and judgment, depending upon the extent to which it is swayed by reason, and by the general temperament. It is not to be expected, therefore, that the business affairs of the country will immediately assume their normal condition. Even though this senseless fear were to instantly disappear, it will take some little time for the complicated mechanism of commerce to get into smooth running shape again.

Any general disturbance in the business of the country immediately brings out a demand for legislation. When legislation can be passed that will prevent the timid from taking fright, it will be possible to legislate financial panics out of existence. Changing human nature by legal enactment, however, has never been a success.

Panics are usually ascribed to "want of confidence," which is only another way of saying fear. Sometimes this fear is well founded, and as a result there is general business depression, which is quite a different matter from financial panic. This was the case in 1893 and the period of hard times following. At that time a political party had come into full control of the National Government, whose professed economic policies were radically different from those upon which the business of the country had been based for a generation past. It was therefore an act of common prudence on the part of those engaged in commerce to keep their business within the smallest possible bounds until the new Government policies should have been established. A succession of poor crops aggravated the situation. None of these conditions prevail at the present time. It would require at least six years, even were the country so disposed, to bring about a complete change in the present political status of the Government, and there is not a single indication of any general demand for, or likelihood of such change. There have been a succession of unusually prosperous years with the farmers, who have become actual lenders of money instead of borrowers, as they were ten years ago. Some dishonesty in high places has been unearthed, but this is nothing new; dishonesty has always existed, and is likely to continue for some time to come. In comparison with the amount of business done, there is far more general honesty to-day than ever before in history. The fact that dishonesty is being exposed and punished is in itself a sign of moral health. Nobody believes that we are living in the Millennium. The fact that no thieves are being caught and punished does not prove that none exist, but only that they are not being discovered. Not only the general business ethics on a higher plane, but the spirit of co-operation and mutual assistance is stronger than ever before.



Life as a Source of Light

LIGHT produced by certain of the lower orders of animal organisms has been known for ages; but the method of its production has remained enshrouded in mystery even up to the present time. We have learned to expect almost anything from microbes and bacteria; but the discovery that they can produce light is nevertheless somewhat startling. The following facts given by the *Scientific American* are both curious and interesting:

The flesh of most sea fishes and other marine animals becomes more or less luminous within a day or two after death. The light is emitted, however, not by the flesh itself, but by certain bacteria which can be collected from its surface, and which are of common occurrence in sea water. A similar appearance, due also to the presence of luminous bacteria, is often presented by meat. These bacteria are harmless to human beings, as they cannot live at a temperature above 76 deg. F., and the temperature of the human body is 98 deg. F., but living cold-blooded animals can be inoculated with luminous bacteria, with surprising results. The Russian physiologist Tarchanoff inoculated frogs with luminous bacteria obtained from the Baltic. The bacteria multiplied in the blood, and caused the entire body of the frog to emit light. The luminescence, which was especially intense in the tongue and other soft parts, continued three or four days. Similar phenomena have been observed to occur naturally in cold-blooded animals. A few years ago the French naturalist Giard found among the sand hoppers that swarmed on the beach at Wimereux one which, instead of hopping, crawled slowly over the sand and glowed brightly. On examination, the body of the little crustacean was found to be filled with luminous bacteria. When other sand hoppers were inoculated with its blood, they also became luminous, gradually lost strength and soon died, but continued to glow for several hours after death.

The observed cases of luminescence in earthworms, mole crickets, and other cold-blooded animals not normally luminous, are probably to be attributed to a similar infection with luminous bacteria or luminous fungi.

The possibilities as suggested by the above description are sufficient to lead the imagination into far-reaching flights. It is well known that the higher animals far surpass the best mechanical devices in generating power from the combustion of various substances,—for animal power is the result of the slow combustion of food. For example, the food which will keep a mule in active service, if burned in the best possible form of engine, would produce but a trifle of the power which the mule is capable of generating. If an animal could be found, or produced, therefore, which would convert the energy of its food into light, all our present light-sources would have to take a back seat in point of efficiency. The firefly lamp by which the Lady of the Lake paddled her own white canoe may yet be the prototype of future commercial light-sources. The discovery of light-producing bac-

teria is particularly suggestive. Imagine a glass vase filled with the proper "culture" of light-giving bacteria, sending out its soft, heatless rays! Or perhaps an aquarium in which luminous frogs and fish disport themselves and light the room. Or, to give the imagination free reign, why not breed bacteria that can stand the temperature of the human body, and as scientists state that they are perfectly harmless, why may not the countenance be made to beam so brightly as to furnish the necessary light for work or pleasure? By the time that this method of lighting becomes general, we shall probably live in concrete houses built in a single day, and be in regular, communication with Mars by means of Niagara electric power.

Narcosis by Blue Rays of Light

According to Consul William Bardel, of Bamberg, a dentist at Geneva, Dr. Radard, after having for several years made experiments with the narcotic effect of blue light, has submitted his results to the Swiss Society of Odontology.

He claims that a complete narcosis can be obtained if the rays of a blue electric light are brought to bear on the human eye, while all other rays of light, particularly of daylight, are kept off of it. The narcosis thus obtained is so complete that, during the same, little dental operations, such as pulling or filling teeth, etc., can be executed without causing the patient the least amount of pain. While the effect of the blue rays is a very strong one, that of violet-blue and green rays is less intensive, and yellow or red rays show no effect at all. The inventor is, as yet, unable to give a definition of the cause of this remarkable discovery.

OPTIC NERVE OF AN EYE BADLY AFFECTED BY MYOPIA.

Camera Helps Save the Eye

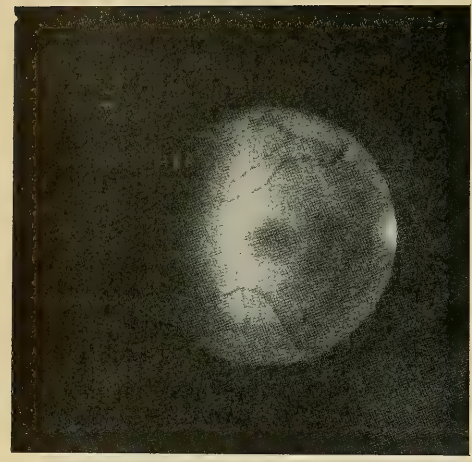
By J. B. Van Brussel.

Dr. Walther Thorner, assistant at the clinic of eye diseases at the Royal Charity hospital at Berlin, has recently made a discovery of great importance in the domain of ocular science, in solving a problem that several practitioners had hitherto studied, but with indifferent results. He has succeeded in photographing the back of the eye and in obtaining good photographic reproductions.

His invention is a large improvement upon the Helmholtz eye speculum, which has permitted only of examining the back of the eye, while now an image of it can be fixed. Owing to this invention the delicate art of the oculist is destined to enter a new phase which will doubtless be the starting point of interesting discoveries in the domain of ocular science.

The failure of all attempts made up to the present to photograph the interior, and the back, of the eye, has been due to the peculiar structure of this organ. It is difficult, in fact, to illuminate the eye sufficiently to obtain a photograph of it; and even upon employing powerful sources of light, the exposure of the organ would take too long and would occasion unendurable pain to the patient.

The apparatus as actually used by the inventor is represented in one of the accompanying photographs. Before coming to this fine improved apparatus, Dr. Thorner in the first place constructed a trial apparatus by means of which he succeeded in photographing the eyes of certain animals, and principally those of cats. As the back of the eye is darker in the man than in the cat, it was necessary to modify the apparatus before it was possible to photograph the back of the eye of the man. Then, starting from good prin-



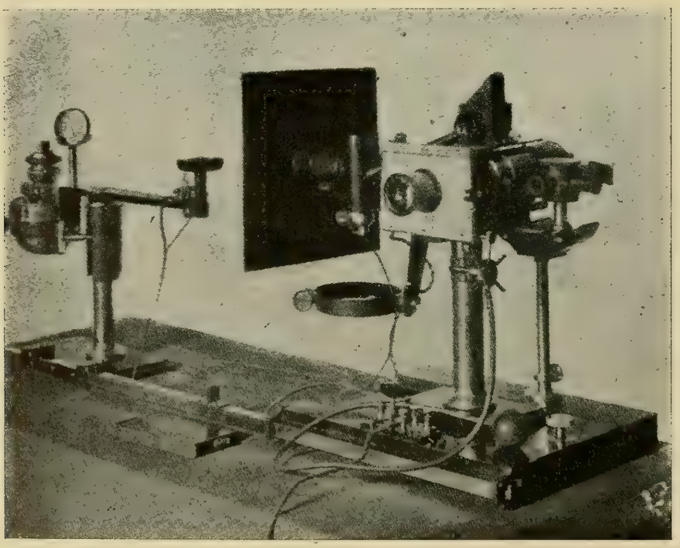
PHOTOGRAPH OF WHAT IS COMMONLY CALLED THE "YELLOW SPOT," THE MOST SENSITIVE PLACE IN THE EYE.

ciples, Dr. Thorner, after patient researches, finally obtained complete success.

The following gives a good idea of his manner of operating with the newly perfected machine:

The wide-open eye illuminated by the soft light of a kerosene lamp, is placed at the entrance of the apparatus. A lens reproduces an exact image of the interior of the eye on a plate of ground glass. After an accurate focussing has been secured, the shutter is closed and set and the ground glass is replaced by a sensitized plate. A simple pressure operates the shutter, and, at the same moment, an electric spark ignites a quantity of flashlight powder. The illumination lasts for a sufficient length of time to allow the back of the eye to be reproduced upon the photographic plate. The images thus formed are slightly imperfect, and it is necessary in developing them to exercise particular care in order that good negatives may be obtained, which shall permit of making positives such as are represented in the photographs herewith.

Among these images may be seen a healthy eye and a diseased one. Here we observe the ramifications of the delicate vessels of the retina, the heavy lines representing the veins and the less conspicuous ones the arteries. It is through the observation of such details that healthy eyes are distinguished from diseased ones. Very short-sighted eyes, for example, are characterized by a peculiar aureola around the center which emits a very light radiation after the manner of a sun. It is, therefore, now possible gradually to follow the progress of an eye disease through its successive periods, and likewise to photograph each of the parts of the interior of the eye separately.—*Technical World.*



THE THOMAS APPARATUS FOR PHOTOGRAPHING THE INTERIOR OF THE EYE.

Commercial Engineering of Illumination

Retrenchment

When a man who can't swim falls into the water, in the sudden terror of the moment he is almost sure to do exactly the worst thing possible—throw up both hands. In the first terror of financial panic business men frequently commit the same blunder; they throw up their hands, figuratively speaking.

The word "retrench" is the echo of the word panic; its very sound suggests to the popular mind business sagacity and virtue. As a matter of fact, retrenchment may be neither, but only a case of throwing up the hands. Its virtue depends upon the direction in which it is exercised.

With a general contraction of cash and credit a corresponding reduction in expenditures and output must of necessity follow. The question is what expenditures shall be curtailed and cut off, and what shall be continued? Unless operations are to cease altogether expenditures must continue to be made; and in saying that those expenditures should be made which bring the quickest and surest return of the money expended is to state a self-evident truth. There is never any desire to retrench on income; and so long as the income can be kept up, retrenchment by way of cutting off the expenditures for legitimate business is wholly illogical.

Retrenchment always aims at luxuries, and never reaches necessities except under the most abnormal conditions. The companies furnishing illuminants, such as gas and electric current, are selling necessities, the use of which will be diminished in an exceedingly small degree by ordinary business depression. We know from direct knowledge that some of the largest lighting companies in the country had record months for business in October. Who has stopped using light since on account of the money stringency? How many merchants are leaving their stores in darkness or semi-darkness on account of the present depression? Is there rather not all the more need for making the store as cheerful and confidence-inspiring as possible? How many householders are going to bed early to save light? Every indication points to the fact that the people in general, "the common people" that we hear so much of, have sufficient money for all necessities and most of the luxuries of life that are within their reach. They are not only using light, but paying their bills when they come due.

To cut off the New Business or Soliciting Department, which is the source of new customers and new cash, would seem at the present time to be a clear case of "killing the goose

"Killing the Goose"

that lays the golden eggs." New business departments are not charitable enterprises. They are to the lighting company what foragers are to the army; they bring in the supplies and keep it alive. Now of all times is it necessary to keep the customers already obtained in good humor, and prevent those who have been labored with from backsliding. If a new business department is not profitable, or at least self-supporting, then it has no excuse for existence at any time—provided, of course, it has had a fair chance—but if a department is bringing in more money than it expends, what is the sense of cutting it off? The only reason that can be adduced is that, under present financial conditions, new customers cannot be obtained; but has this been proven? Is it not a case of getting scared before being hurt?

Furthermore, a competent corps of

solicitors, capable of making a profit to the company, is something that cannot be created in a day. Men must be selected, not only for their individual worth, but for their ability to pull together. They must not only learn the general and special conditions under which they will have to work, but must make personal acquaintance with their prospective clients and win their full confidence. This requires both time and labor; but when once all of this has been accomplished, it becomes a valuable asset if not interrupted. To disband such an organization is not only to lose the regular business which they bring in, but to destroy one of the most valuable assets in business, namely, good will. Any solicitor or salesman would rather begin on a stranger than one whose interest has been aroused, but from lack of attention, has been allowed to grow cold. To discontinue a new business department is therefore to lose the advantage that has been gained in bringing a large number of prospects up to a point where they are interested in the proposition, and will take it up as soon as personal or general conditions will permit.

If retrenchment must be made, is it not the part of wisdom to consider very carefully before reducing the department which brings in the sinews of war? If business will not come without asking in flush times, it certainly will not do so in hard times.

There is no surer way to produce and continue hard times than to stop trying to get business.

Residence Lighting and the Lighting Companies

In point of numbers, residences furnish the large majority of customers of gas companies, and in the larger towns, a very considerable number of the customers of central stations. The good will of this large clientele is of importance, both for the sake of the revenue directly obtained from residence lighting, and also on account of the large lighting installations which a certain number of them use in connection with their business.

Aside from the fact that every customer is entitled to the best service possible for the amount he pays, there is a double reason, therefore, for not only giving good service, but for giving such personal attention as will make him feel that the lighting company is actually looking after his welfare in this regard. Virtue, which, as the result of necessity, is a virtue still, and good service and personal attention, even though given for the wholly selfish motive of securing custom, is quite as beneficial to the consumer as if it resulted from purely humanitarian motives. That public good will and confidence which constitutes a very considerable portion of the assets of every business, is particularly valuable in the case of a public service corporation, whose very existence depends upon the good will of the people, and yet what proportion of the householders using gas and electric light ever come in contact with the lighting companies, except the meter reader or the collector? An occasional visit from an "inspector" may take place, but his inspection is for the purpose of seeing that there is no mechanical defect in the installation that will cause the company loss, and possibly also to see that no electric current is being purloined without passing through the meter.

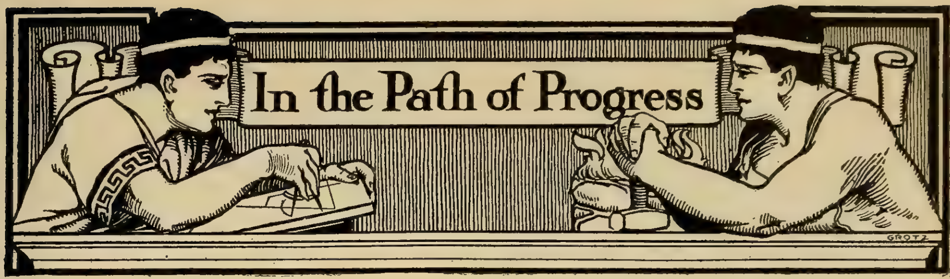
The value of a customer's good will

is not always to be measured by the amount of his personal lighting bill. The scriptural admonition to entertain strangers for the reason that you may thereby entertain an angel unawares, is applicable, in a certain sense, to the treatment of the small customer. There is no telling what influence the man whose personal lighting bill is only a couple of dollars a month may have with interests that are powerful either commercially or politically, or what harm he may do by apparently feeble "knocking." Lighting companies have an unsurpassed opportunity for making personal friends of every one of their customers. Every contract expressly gives the company the right to inspect its property on the customer's premises, and this gives an *entrê* to an inspector which it would in many cases be exceedingly difficult for an ordinary solicitor or salesman to secure. A gentlemanly inspector would have no difficulty in being received by the mistress or master of the house, and of personally examining the entire lighting installation. This would give the fullest opportunity that could be desired for making helpful suggestions of ways of improving the quality of the light, and often of cutting down the expense.

This last suggestion may sound like rank heresy, but the wisdom of satisfying the customer, even though it reduces bills for a time, is now generally accepted, it being a matter of demonstrated fact that in the end the total income will be increased by such a policy.

The case mentioned by Mr. Owens in regard to the boarding-house shows a condition that should not be allowed to exist; an out-of-date and defective system of gas lighting, which has been in use for years, was only improved by the householder paying an outside party a fee for the few trifling suggestions made. By the installation of a few mantle burners, as Mr. Owens points out, entirely satisfactory illumination could be produced, but this was not done even by the professional "improver" who received his fee.

The problem of improving the great majority of residence lighting systems at almost no cost to the householder or company is so simple that the neglect of the opportunity on the part of lighting companies is a sin of omission which it is difficult to pardon. It is true that this fact is being recognized to an appreciable extent by the electric lighting companies, who see in this a means of putting in electric light and displacing gas. With a few exceptions, however, the gas companies seem to be entirely oblivious of the benefits to be gained by such a course, or the danger threatened to their last stronghold, so far as lighting is concerned, by the electrical interests. Thanks to the manufacturers, the advantages of gas ranges and stoves have been very thoroughly exploited by every kind of demonstration, private and public. It seems to be assumed that gas will continue to be used for lighting where once installed, because of its cheapness, or for some other reason not apparent to an impartial observer. The wisdom of looking after small things, and the rewards therefore, have been recognized and preserved in "sayings," from the Bible down to Ben Franklin. The householder, though a "little thing" compared with some other customers, is worthy of the utmost attention and cultivation on the part of lighting companies.



Glass as Decorative Material for Lighting Fixtures

It is generally conceded by those who have made any study of the development of lighting fixtures, that they reached their highest artistic excellence in France during the seventeenth century. Although candles afforded the best light-sources available at that time, the chandeliers and other lighting devices have served as models of beauty and art ever since. Although elaborately wrought metal was used to a certain extent, the finest effects were secured by the use of crystal glass as a decorative material. We have repeatedly called attention to the fact in our columns that glass is the logical material for lighting fixture embellishment, for the reason that, while exhibiting the beauty of its workmanship by day, its greatest beauty is brought out when in use, by the lights which the fixture supports. Metal work may show to fair advantage by daylight, but when in use generally becomes a mere black blotch.

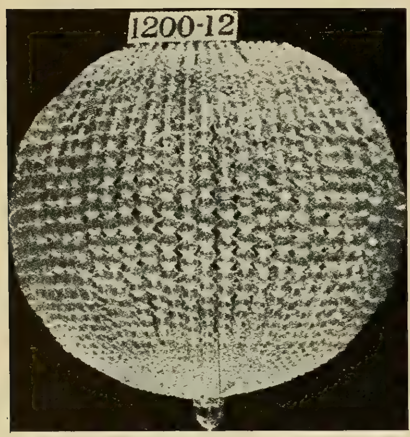
Although glass working was brought to a comparatively high state of perfection several hundred years ago, the fact must not be overlooked that it has reached a far higher state of perfection at the present time. Decorative art always implies hand-work, and requires, in addition to a workman of artistic temperament, a high degree of patience, and a love of his work for its own sake. These are qualities which belong to a far greater extent to the European workman than to the American. As a result, the finest art work in glass is still to be found in Europe; Bohemia being the center.

There are many forms in which glass is available as decorative material for fixtures. Beads and ornaments of pure crystal, variously cut and fashioned with jewel-like faces; beads of various sizes and tints; shades and globes simulating the petals of flowers, are a few of the forms. The application of these decorative elements offers an inexhaustible field for the American designer.

Mechanically, the foreign made fixture does not satisfy the requirements of the American public. Realizing this fact Messrs. Siegman and Weil, of New York, have established a special assembling department in which the materials of the European glass worker can be fashioned into designs and forms of fixtures appealing to American taste, with the strength and mechanical excellence which is demanded here. In this they have shown not only an appreciation of the conditions of American trade, but a very commendable enterprise in establishing their own work-shops.

We recently had the pleasure of a complete inspection of both their showrooms and work-shops, and even though we were aware of the large variety of glass work obtainable in

foreign markets, the completeness of their stock, and the variety and beauty of the specimens shown, was a revelation to us.



A Glass Bead Globe on a Silvered Wire Framework,

the only construction giving strength and permanence.

As to Switches

In a recent number we discussed the question of the extent to which illuminating engineers must be familiar with electric wiring, and called attention to the fact that a good lighting installation was often unsatisfacory to the user on account of the faulty placing, or insufficient number of switches.

Switches would doubtless be placed more generally and at more convenient points if a switch of suitable mechanical construction could be obtained. Messrs. Machen & Mayer, 12th and Buttonwood Streets, Philadelphia, offer a flush switch which they appropriately call the "Shallowest," for the reason that it is only 1 7-16 inches deep, which adapts it for use in shallow partitions and other places where an ordinary flush switch would be unavailable. Their general line of switches and receptacles show ingenuity in design, and good mechanical construction, and are commendable articles of their kind.

Benjamin Wireless Cluster Patent Sustained

The Circuit Court of Appeals for the Second Circuit (Judges Lacombe, Coxe and Ward) has just rendered a decision in Benjamin Electric Mfg. Co. versus The Dale Co. and John H. Dale, holding Claims 5 and 7 valid and infringed by defendants.

Judge Holt of the Circuit Court held the patent valid but not infringed; the Court of Appeals reverses the lower court and holds infringement as well as validity.

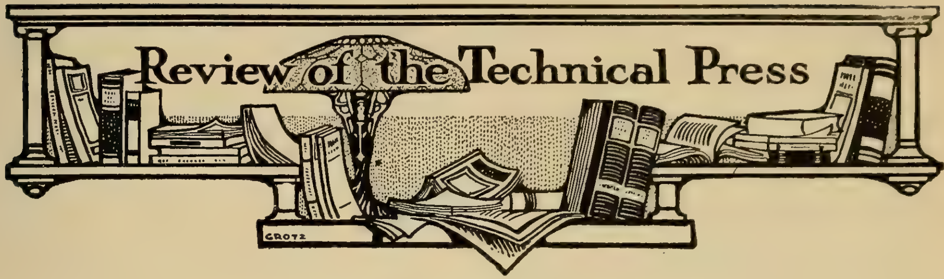
An injunction is granted against defendants and their agents as well as an accounting.

According to this decision an injunction and accounting are awarded as to all *multiple* wireless clusters.

By virtue of an order of court heretofore entered in the companion suit, a similar decree for an injunction and accounting will issue covering all *series* wireless clusters made and marketed by defendants since 1904 when infringement commenced.

Personal Mention

J. W. Taylor, traveling salesman for the Beardslee Chandelier Manufacturing Company, of Chicago, has accepted a local position with Edward Miller & Co., of Meriden, Conn., at their Chicago branch, located at the corner of LaSalle and Lake Streets, Chicago, where he will be found after January 1st, 1908.



American Items

Street Lighting Contracts, by Alton D. Adams; *Municipal Journal and Engineer.*

The writer gives well-chosen arguments in substantiation of the proposition with which he begins his article:

In the interest of cities and towns, contracts for street lighting should usually be made for not more than one year, and should be for gas or electric energy consumed in lamps of given types, rather than for the sale of light alone. Unless street lighting contracts are treated in this way, the public cannot expect to get a fair share of the reductions that are being made in the cost of light.

Electricity as Applied to Stage Lighting, by John H. Kliegl; *Electrical Review.*

An illustrated article dealing in detail with the wiring and general installation necessary for modern stage lighting.

Characteristics of the Magnetite Arc, by G. M. D'O. Dyatt; *Electrical World.*

Gives results of a series of experiments carried on by the writer in this comparatively new and important field.

Electric Lighting in New England, by William H. Stuart; *Electrical World.*

The writer begins with the following interesting statement of general conditions prevailing in New England:

In the smaller cities throughout New England electric lighting takes the smaller portion of the central station load, motor business taking the greater share. The number of gas consumers is overwhelmingly greater than the users of the electricity. This state of affairs can be accounted for by the fact that the cities and towns of New England are manufacturing centers, having about three-quarters of their population employed in the factories and mills with an income capable of allowing only oil or gas to be used as an illuminant. Then, again, the stores are open only one or two evenings each week.

The central station managers have found that the lighting business, if any was to be obtained, is commercial lighting, and in the majority of the cities low and attractive rates are offered for this class of business.

Tungsten Lamps for Street Lighting; *Electrical World.*

Description of an installation at Grosse Point Farms, Detroit, Michigan.

EDITORIALS.

Two Candle-power Sign Lamps; *Electrical World,* November 23.

Incandescent Lamp Tests Here and Abroad; *Electrical World,* December 7.

Bill-board Lighting; *Electrical World,* December 7.

Practical Tests of Illumination; *Electrical Review,* December 7. A discussion of Mr. Pearson's paper on the Lighting of the Marshall Field Store, Chicago.

High Resistance Tantalum Filament; *Electrical Review.* A short description of the filament recently patented by the British Thomson-Houston Company.

Foreign Items

COMPILED BY J. S. DOW.

MR. J. S. DOW.

THE growing interest in the question of illumination in England has recently found expression in the editorial notes in several of the technical journals.

Under the title of "Light-production and Illumination" *The Electrical Review* draws attention to a very vital distinction in illuminating engineering, namely, between the mere production of light—however efficiently—and the satisfactory use of the light we have succeeded in producing.

Much remains to be learned as to the qualities of certain varieties of light for special purposes. The difficult physical problem of so marshalling the atoms of a light-giving substance as to secure efficient results is complicated by the difficult physiological aspects of the question. We are closely concerned with the peculiarities of the eye itself and the eye, when acted on by very weak light, is in a very different condition to that existing at ordinary illuminations. Again it may be that the variety of light which is most satisfactory for reading by, is not that which is best for general illumination. The *Electrical Review* sums up the situation thus: "This point of view is far away from that of the average man with a photometer, who makes simple tests of 16 C. P. lamps. It shows that it will probably be years before the amount of knowledge concerning illuminating engineering will be sufficient to render operations in this field at all commensurate with the development in other spheres of engineering activity."

In a subsequent editorial, however (Oct. 25), the same journal expresses a fear that the scientific side of illumination may be so strongly put forward that the common man may be scared into the belief that illuminating engineering is too complex for him to understand. The writer then proceeds to state some broad and simple rules of illumination for the guidance of all.

The *Gas World* (Nov. 2) expresses its appreciation of the note just referred to, but concludes, "We quite agree that the fundamental rules of good lighting are few and not at all difficult to master, and that there is certainly no need for the creation of another technical society in England to cultivate this department of a gas

or electrical engineer's professional acquirements, which has already been advocated in some quarters."

These different views are especially interesting at the present moment when the formation of an illuminating engineering society in England is impending. It is certain that the study of lighting and illumination cannot both be as simple as the *Gas World* suggests, and yet depend upon little understood scientific facts as *The Electrical Review* has declared. It will, however, be readily admitted that the most immediate and urgent needs of illumination can be met by considerations of a simple, common-sense character and that much good work can and will be done by those who, for instance, have little knowledge of physiological optics or the theory of the radiation from incandescent materials. For the moment these urgent needs must be kept in view. Yet, as *The Electrical Review,* in the editorial referred to, made very clear, these scientific considerations cannot be shelved indefinitely if illumination is ever to become an exact science.

And the very existence of this difficult scientific background only proves the need for a body of men willing to give their attention to its complexities.

The complex nature of the physiological aspect of the question happens to be very well illustrated by a recent lecture by Mr. Val. Mackinney before the West Riding Optical Society. Mr. Mackinney dealt with the subject from the point of view of the optician. He distinguished between our ability to discern form and color, and explained the functions now attributed to those minute retinal organs the "rods" and the "cones." The theory of the action of these organs is capable of explaining many of the curious effects in color-vision, such as the "Purkinje effect" and the fact that we are all practically color-blind at very weak illuminations. Mr. Mackinney also dealt with the relation between visual acuity and illumination, and showed how this too, could be partially explained by the action of the rods and cones respectively. Lastly, he dealt with the difference in visual acuity for light of different colors, which is subject to two limits of a physical and physiological character, and is also complicated by the chromatic aberration of the eye. As a result of this peculiarity red light is found to be most serviceable in revealing detail, when the object is viewed at a distance of a few metres or so, while for very near vision, on the contrary, the blue end of the spectrum is best.

Wild (*Electrician,* Nov. 8, 1907), deals with the sensitiveness of different forms of photometers, including his own form of flicker photometer. He finds a certain form of grease-spot photometer the most sensitive when the lights are of the same color, though, as a rule, the Lummer-Brodhun instrument is preferable to the grease-spot, owing to imperfections in the latter type of photometer. In the case of lights of different color he prefers his own flicker instrument.

The value of such comparative experiments is, however, restricted, when, as in this case, they are the result of the observation of a single observer. Certainly many of these results would be reversed by the author's own experience. Wild, for instance, seems to find a degree of sensitiveness in all the instruments which the average observer would hesitate to claim. In one case the sensitiveness is given as 0.4 per cent. This means that if the photometer were in balance about the middle of a two-

meter bench, a movement of *half a millimetre* either way would throw the photometer distinctly out of balance!

In the *Phil. Mag.* for November the author describes some experiments with a form of flicker photometer, which depends upon the cosine law, the sources of light being maintained stationary. This is accomplished by the rotation of a rectangular wedge about the line of intersection of the photometrical surfaces as axis. It was found, however, that though convenient, "angle-errors" had to be carefully guarded against in photometers of this type. Some experiments, in color-photometry are also described, the agreement between the "flicker" and "Equality of Brightness" methods being in this case very good. Crova's method was also examined, the conclusion being reached that the method is only applicable in the case of continuous spectra, and not rigid in the case of spectra broken up into isolated bright lines, as in the case of the mercury lamp, for example.

Drs. Hugo and Paul Krüss (*Jour. für Gas,* etc., Nov. 2) describe a form of apparatus specially intended for the study of the distribution of light from inverted incandescent mantles.

Weinbeer (*Elektrot. Anz.,* Oct. 13) deals with the grouping of sources of light and the design of reflectors intended to secure perfectly uniform illumination. In a previous article the author had divided the usual sources of light into four groups according to their distribution-curves. After dealing with the grouping of large numbers of these lamps, he turns to the question of reflector and shows how the natural curve of the upright incandescent mantle can be modified by the Holophane globe and the "Autosit-Schirm" of Schott of Jena, which is a conical reflector composed of a special variety of opal glass. He also proposes to devise reflectors specially adapted to the four classes of lights referred to, and gives an illustration of the general shape of these reflectors.

Some German patents of reflecting shades, etc., are also described in the *Zeitschrift für Beleuchtungswesen* (Oct. 30, 1907).

Professor Teichmuller, in a recent article (*E. T. Z.,* Oct. 17th, 1907), compares the standard specifications for glow-lamps enforced in Germany, Austria, Switzerland and England respectively. The conditions enforced in Switzerland and Austria naturally resemble those contained in the earlier German specification. The English specification—the most recently issued—deviates somewhat further, but this, too, is founded on the same general considerations.

The latitude of variation in watts per c. p. allowed in the different specifications differs somewhat, Austria allowing only 4 per cent., while in England a latitude of 8 per cent. is allowed in the case of individual lamps, and an average of 5 per cent. All countries specify that photometric measurements must refer to M. H. C. P., but the methods of testing the M. H. C. P. recommended by the different nationalities differ.

Fortunately, all countries are in agreement as to the definition of "useful life," namely the time elapsing before the c. p. of the lamps in use has fallen 20 per cent. At present, life tests are to be carried out at the P. D. on which the lamp is intended to run. The German, Swiss and English specifications do not definitely propose "overrunning life-tests," though the two former nations refer to their method.

Austria-Hungary proposes to test

lamps by running them for 24 hours at 20 per cent. above normal pressure. Recent experiments are said to confirm the value of this test. Manufacturers, however, point out that the method would have to be applied with caution, to the comparison of different makes of lamps, owing to the different qualities of the carbon used.

It may be noted that, in the case of England and Switzerland the conditions imposed by the specification are always applicable, while in Germany and Austria they only apply when the number of lamps ordered exceeds a certain number.

The author mentions the general impression among manufacturers that these conditions are too stringent to be rigidly enforced. Even so, however, the educational value of such a specification, in leading the public to expect and insist upon certain reasonable guarantees of life and efficiency cannot be gainsaid.

Recent issues of the *Zeitschrift für Beleuchtungswesen* contain notes on further processes connected with the manufacture of glow-lamps; for instance, a new method of exhausting the bulb by means of a small tube let into the base of the lamp. The exhaustion of the bulb, and sealing in of the filament, are thus carried out in one operation, and the production of the "pip"—a fruitful source of breakage—is avoided.

The scientific principles underlying the new metallic glow-lamps have been the subject of a recent paper by Stark (*E. T. Z.*, Oct. 24th, 1907). The author distinguishes between luminiscence and temperature-radiation, and points out that the new metallic filament lamps must owe their efficiency mainly to high temperature, because difference in quality of the radiating surface has only a slight effect upon the performance of incandescent bodies at a high temperature. During the discussion of this paper, one of the speakers referred to some previous experiments published in the *E. T. Z.* which seemed to suggest that the temperature of the Osmium filament was actually lower than that of the carbon filament. Herr Stark, in reply, stated that the more recent work of Lummer and others did not confirm this result.

The Electrician (Oct. 25th and November 1st) contains a report of some experiments by W. L. Upson, recently described before the Physical Society, and bearing on the physics and chemistry of the arc. He deals with arcs between electrodes of different materials, burning in atmospheres of various gases, and gives curves connecting P. D. and current, etc., and the corresponding equations, similar to those obtained by Mrs. Ayrton for the carbon arc.

The attention of those in England interested in gas-lighting has lately centred in the Exhibition at Manchester, and recent numbers of the English gas journals contain descriptions of the exhibits. In an editorial comment on the Exhibition, the *Journal of Gas-Lighting* refers to the revolution accomplished by the inverted burner. At the last great gas exhibition, three years ago, the inverted mantle had only just arrived. Now makers are one and all turning their attention to devices for transforming upright into inverted systems.

One exhibit at the exhibition which has received special attention is the air-petrol system of lighting, in which a mixture of 98.5 per cent. air, and 1 1-2 per cent. gas is utilized to render the mantle incandescent. The method seems to be undeniably cheap. It is stated that 1,000 c. p. hrs. are ob-

tained at a cost of 0.8d., as compared with 3.2d. in the case of ordinary gas at 3/- per thousand feet. The latter figure, however, seems to assume that only 10 c. p. per cubic foot per hour of gas is available, certainly a somewhat low estimate, even for ordinary burners, while high pressure burners yield as much as 30 c. p. per cubic foot (*Gas World,* Oct. 12th).

Very similarly efficient results are claimed for the "Sakula" lamp, a German lamp on the same principles, which yields 400 H. K., the cost per burning hour being only about 3 pfennigs (under 1-2d). The cost per 1,000 c. p. hrs. works out to little more than a penny (*Zeitschrift für Beleuchtungswesen,* Oct. 30, 1907).

The theoretical aspect of these petroleum-air gas burners seems to be something of a puzzle. The calorific power of the petroleum gas seems to be very low, and yet the flame temperature secured is sufficient to bring the mantle to bright incandescence (Webber, *Gas World,* Nov. 2d).

Attention may be next drawn to two recent papers on gas-lighting, by H. Kendrick and H. Burgess (J. G. L., November 5th).

The former deals chiefly with the maintenance and adjustment of incandescent burners. The latter describes the high-pressure system of lighting on the Midland Ry. The author mentions the effective high-pressure lighting of the new Victoria Station in London, where a pressure of about 50 inches of water is used. He also describes the Sugg system in use on the Midland Ry., and shows how, as the pressure is increased from 1.45 up to 12 inches, the efficiency alters from 14 to 30 c. p. per cubic foot of gas per hour, while as much as 40 c. p. per cubic foot can be obtained with a pressure of 50 inches.

Mantles, however, have to be specially designed to withstand such pressures, and this can be accomplished by the use of a double stocking, or by a specially strong mesh.

"Anti-vibrators" are attached to lamps in use on the railway platforms, and constantly subjected to the rattle of passing trains, but in the erecting shops they were not found necessary. Photographs are shown illustrating the white wooden reflectors employed in these shops, and diagrams showing the uniformity of the illumination so secured (*Journal of Gas-Lighting,* Oct. 15, 1907).

Two interesting special appliances for the study of incandescent mantles have recently been devised. The first of these is intended to test the vibration and "shock-resisting" power of mantles, and is so arranged that as a handle is turned the mantle is alternately lighted and extinguished, and simultaneously receives a series of shocks. By this means the instrument reproduces on a more severe scale the most unfavorable conditions to which a mantle is subjected in active use (*Journal of Gas-Lighting,* Oct. 22d). The second is an optical device by means of which the change in shape of a mantle during its life can be accurately studied. The writer points out that the diminution in c. p. of a mantle during life is due, in no small degree, to the fact that it gradually changes in shape. A rightly designed burner provides a flame of such a shape that the mantle utilized with it is completely encircled by the hot outer region of the flame. Therefore, as the mantle changes its shape, portions of it are withdrawn from this hottest region of the flame, and do not glow as brightly as they should do.

In increasing the life of incandescent mantles, our object should there-

fore be to devise a mantle which retains, not only its exact original chemical proportions, but also its original correct shape.

Finally, attention may be drawn to two recently-delivered lectures by J. H. Brearley and Professor Vivian Lewes (*Journal of Gas-Lighting,* Oct. 29th and November 5th), who dealt with the merits of gas from the hygienic point of view.

The adherents of electric lighting have not failed to point out its presumable advantage of using up none of the oxygen present in a room and leaving no products of combustion. Doubtless this point has been over-emphasized in the past, and the representatives of gas-lighting have even contended that modern systems of gas-lighting, wisely installed, are actually preferable to electric lighting, from the hygienic point of view.

In the two lectures referred to, for instance, it is pointed out that the ascending air from the gas burner can be profitably utilized to promote ventilation, which might otherwise have to be secured by the expenditure of energy in electrical fans, etc. It is further suggested that the amount of carbon dioxide in the atmosphere of rooms rarely exceeds the healthful limit of six parts per 1,000, that it is the organic products of respiration in crowded rooms which is most harmful, and that a gas light is, to some extent, of service, by carbonizing these organic particles, and so "sterilizing" the air.

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The Electric Conductivity of Some Carbides and the Preliminary Steps in the Manufacture of Metallic Filaments for Incandescent Lamps

By Dr. C. Richard Boehm.

E. Wedekind communicated in No. 52 of this publication (*Chemiker-Zeitung*) a report concerning the properties of the carbide of zirconium and furnished new observations on the conductivity of this substance.

This leads me to relate here my own observations on some carbides made by me in 1901-1902 in conjunction with a review of the German patent-literature concerning the application of carbides in the industry of electric illumination.

The attempts to utilize glowing bodies consisting of a conglomeration of conductors of the first and second class is almost exclusively based on the formation of carbides. This way the description of the preliminary steps in the process of formation of metallic filaments for incandescent lamps practically supplements my previous article entitled "The Newest Electric Incandescent Lamps" (see *Chem.-Zeit.*, 1906, p. 694-696, 729-731).

As known, the metallic carbides are divided into two classes, namely, those decomposed and not decomposed by water. The carbides of the rare earths, with the single exception of the carbide of zirconium, are decomposable by water. Zirconium carbide is therefore singled out as a material for filaments for incandescent lamps. According to Sanders' patents[1] filaments are manufactured by the incandescent-lamp works of Dr. Hollefreund & Co., of Berlin. The product of reduction attained according to the method of Dr. Winkler[2] by the means of magnesium is used as a raw material. The oxide of zirconium reduced by the means of magnesium in an atmosphere of hydrogen and purified with dilute hydrochloric acid furnishes an amorphic black powder. The applicant for the patent considers this compound as a hydrogen compound. Hollefreund even claims to have determined by actual analysis the formula of this compound as ZrH_4 exactly.[3] Nothing could please Dr. Winkler more than this formula, as he claims to be able to determine the valencies of various elements with the aid of their hydrogen compound. However, he succeeded, in agreement with other investigators, to arrive at the conclusion that only little hydrogen is taken up by the reduced substance. G. H. Bailay is of the opinion that the black powder is principally a low oxide of zirconium, ZrO, with some metallic zirconium.[4] Dennis and Spencer arrived at the same conclusion.[5] Wedekind and Hauser (private communication) together with the author doubt the result of Hollefreund's analysis.

My extended experiments, conducted exactly according to Sanders' specifications in his letters patent on the product of reduction by Winkler's method, all testify in favor of a conglomeration of a low oxide of zirconium with undissociated oxide of zirconium, some hydrogen and nitrogen. The recent work of Hauser on sulphate of zirconium justifies the existence of such law on oxide of zirconium.[6]. Matignon[7] and Moissan[8] and some others[9] have proven that nitrogen is being absorbed with avidity by the pure metals forming the base of rare earths. The principal product of reduction, according to Winkler's method, is, according to the specification of the mentioned patent, turned into a paste by the means of some binder of organic origin. The paste is squirted into thin filaments. The latter are then dried and, in order to carbonize the binder, subjected to a process of baking at a temperature of about 300° C., preferably in an atmosphere of hydrogen. The reduced zircon-earth does not conduct electricity and may be made conductive only in the presence of a sufficient quantity of carbon in the filament, emanating from the organic binder, and under the stress of high-tension currents. In other words, the formation of a carbide is requisite in order to turn the filament into staple conductors. Although the carbide-filament is formed in an atmosphere of hydrogen,[10] the carbide remains nevertheless unreduced by the hydrogen.

Even if one would succeed to provide the surface of the filament with a layer of metallic zirconium by the means of some method similar to that of Hollefreund[11] a carbide of zirconium must always be formed at the high temperature to which the filament is subjected during illumination.[12] The circumstances are different in the case of a tungsten-filament as the corresponding carbides are being formed very sparingly, if at all. When the filament is overstrained by the passing current the

[1] The references for the entire article will be given at the conclusion.

carbon, as in the case of osmium-filaments, distills over and condenses on the walls of the bulb. This phenomenon is rather favorable to the art of modern incandescent lamp production. A filament made of metallic tungsten cannot be monopolized by a patent, as it was proposed for use as early as 1885 instead of carbon filaments.[13] The so-called paste-method cannot equally be protected by letters patent. Consequently the manufacture of tungsten-filaments for incandescent lamps is free to the public.

The name of the newest lamps by the anagramm osram points to an alloy. In spite of the fact that the zirconium-lamp works of Dr. Hollefreund[15] recently also turned to tungsten, and only since that time succeeded in producing satisfactory products, the name zirconium or Z-lamp was retained. Hollefreund extended his zirconium patent in a recent application so as to embrace tungsten, but it is generally known in lamp manufacturing spheres that the new lamps do not contain zirconium in spite of their name.

It would be preferable in the future to drop the name zirconium in order to avoid misunderstandings. My experiments with the reduction of rare earths according to Winkler's method lead me to the observation that the products of reduction of zirconium, thorium or ytter-earths possess the property, when heated in an atmosphere charged with carbon, to absorb the latter. For instance—it is possible to replace after the completion of the reaction the hydrogen by a carbonaceous gas. The degree of absorption of carbon may be controlled and regulated by shorter or longer subjection to the action of a carbonaceous atmosphere, by its dilution with hydrogen or other indifferent gases. In this way, for instance, are being dissociated with precipitation of carbon illuminating gas, ligroin-vapors and carbonic acid.

Berzelius demonstrated in 1824 the decomposition of carbonic acid by a zirconium compound formed by the reduction of a potassium-zirconium fluoride with the aid of potassium.[16] It was also known, for instance, that sodium and potassium turn into oxides in a carbonaceous atmosphere in order to be transformed later into carbonates. Amorphous carbon is separated just as in the case of magnesium.[17] This carbon circulates in the vessels and finally settles on the walls of the vessel. No intimate mechanical combination, as in the case of a reduction according to Winkler's method, is produced.[18] The products of reduction of zirconium heated in a carbonaceous atmosphere at first show a considerable change in electric conductivity in comparison with the original black powder. The product heated in hydrogen does not conduct at all, but turns conductive after subjection to carbonization. This enhanced conductivity varies in intensity according to the duration of the carbonization process in quite wide limits. The treated compound is protected from atmospheric deterioration, while the crude powder is to a great degree pyrophoric, especially when kept in a closed and sealed glass-tube without hydrogen. The degree of conductivity can easily be noted with the aid of a measuring instrument connected with an iron rod as one terminal and an iron plate on which the powder is placed as the other one.

Substances containing the least quantity of carbon and yet retaining their conductivity are best adapted to be used as materials for incandescent filaments. An excess of carbon causes the blackening of the lamp-bulbs. It was empirically ascertained that carbon compounds of zirconium, as we will call them for the sake of brevity, containing less than 8 per cent. of carbon furnish a non-conductive filament (only very short filaments, not to be used in practical illumination started at high tensions). The contents of carbon must reach 10 per cent. in order that long filaments should glow, *i. e.*, conduct well. The filaments shrink considerably, but the shrinkage is rather uniform and the slope of filament is not distorted. A filament of such composition possesses a gray metallic appearance, its mechanical strength was satisfactory, and it can be easily fused into the glass bulb. However, the life of such a filament is rather short on account of its tendency to melt at an excessive voltage.

In order to obviate that the filaments were preliminarily reduced prior to their formation into threads in electric furnaces, oxidation is avoided by conducting the melting process in an atmosphere of hydrogen. The ten per cent. of carbon dwindle down to five per cent. and the conductivity is reduced to zero. There was nothing left but to mix these impoverished compounds with normal zirconium carbide. Moissan was the first to prepare zirconium carbide. We know at present two carbides of zirconium, ZrC and ZrC_2, containing 11 resp. 21 per cent. carbon. However, it is possible to prepare compounds containing lower quantities of carbon. I could modify the carbides of zirconium prepared according to Moissan's method by fusing them

with zirconium-earth. But the resulting compounds always retained some carbon. The degree of conductivity of carbides is governed by the quantity of carbon they contain. Ten per cent. of carbon, for instance, was sufficient to impart conductivity to short filaments only. Only carbides containing 14 per cent. carbon furnish filaments conductive irrespective of their length, while, as we have seen corresponding carbon compounds are conductive when containing only ten per cent. carbon. The durability of filaments prepared of carbides is in no way superior to that prepared of carbon compounds. A conglomeration of zirconium fluxes with carbon compounds of zirconium containing ten per cent. of carbon furnish also filaments conductive in all lengths. Zirconium fluxes mixed in all possible proportions with carbon-compounds of zirconium were prepared and manufactured into filaments. But the durability of these filaments was rather unsatisfactory, so that their fusion into the lamp-bulbs was fraught with great difficulties. Observations proved that in this case the initial high tensions rapidly dropped down and turned constant only after long burning, in consequence of which the consumption of current was raised to a high degree.[19] This was the reason why the patent relating to the process was withdrawn.[20] It is to be mentioned also that extensive experiments were conducted with the products of reduction according to the method of Winkler. The results were always the same, namely, the addition even of small quantities of the Winkler products of reduction deprived the filament of its conductivity. Even an intimate conglomeration of 70 per cent. of zirconium carbide with 30 per cent. of Winkler's product of reduction, recommended at one time by the Electrodon Society, did not lead to more satisfactory results. The filaments prepared in this way did not show any different, not to say better, properties, than those prepared with the aid of carbon compounds of zirconium.[21]

With the use of the carbide of boron all difficulties seemed to be done away with. The use of the boron metal itself seemed to be excluded. The filaments prepared of this metal with a carbonaceous (organic) binder disintegrated at once when subjected to glowing in a bed of carbon-dust and under the exclusion of air. Even a conglomeration of nitrogen and boron compound with carbon formed into filaments showed the same behavior.[22] A considerably more favorable result was attained when boro-nitrogen compound conglomerated with carbon were preliminarily fused in an electric furnace and the carbide of boron thus produced was utilized for the purpose of formation of filaments. The filaments could be easily carbonized even without exclusion of air. The filaments easily start to conduct and possess favorable degrees of conductivity. However, the use of pure carbide of boron is excluded, as their durability is rather very slight. Beside this the filaments turn spotted and then burn easily through. But the high electric resistivity of the carbides of boron influences favorably other carbides. Carbides of boron were conglomerated with the carbides of zirconium or compounds of zirconium and carbon. This way the resistance of these bodies was considerably increased by the addition of considerable quantities of the carbide of boron. But this addition had the disadvantage of lowering the durability of the filament. The addition of 20 per cent. did not cause any marked increase of resistance. Better results were attained when 10 per cent. of carbide of boron were conglomerated with a carbide of zirconium containing only 7 per cent. carbon and worked up into filaments. The latter proved to be conductive in all lengths and were relatively durable. Only their tension dropped rather fast. Their color was gray, reminding of metallic zirconium. It was easy to fuse these filaments into the bulbs of the lamps. But the bulbs were blackened after a few hours of burning thoroughly, in consequence of the light pulverization of the filament. The reason of this phenomenon was probably that the temperature in the filament during glowing was not high enough to fuse the materials together. By preliminary fusion in a furnace a more perfect conglomeration was attained. At first a flux of carbon compounds of zirconium with nitrogen compounds of boron and carbon was effected. However, as it was a loss of time to prepare carbon compounds of zirconium and then subject them to melting, zirconium-earth was directly fluxed with the calculated quantity of nitrogen compounds of boron and carbon. Filaments prepared of this conglomeration showed a less smooth appearance, but were better sintered together. Their durability was quite satisfactory, as they did not shrink at all; they could also be easily shaped into horseshoe-shape. It was not advisable to make additions to the fluxes as they invariably caused a blackening of the lamp bulbs. The life of both filaments

reached 100 hours and more. The high contents of carbon was rather unfavorable as was the electrolytic pulverization of the carbide of boron (S. F. Kuchenitz, footnote 22).

The carbon was therefore replaced by boron, *i. e.*, it was suggested to return to boricides. It was attempted to flux zirconium-earth with the nitrogen compound of boron alone. The filaments prepared this way conduct the current well and were all that could be desired as far as durability was concerned. It was thought that the resistance could be desirably enhanced by the increased addition of the nitrogen compound of boron. It turned out, however, that the boron was gradually pulverized and the globes blackened. It was proved advisable to limit the addition of boron to a minimum so as to just attain the desired conductivity of the filament. The addition of the oxide of cerium to the flux was hardly to be recommended on account of the known unfavorable properties of the carbide of cerium, which would extend to the filaments. Filaments of small cross section showed especially a rapid spotting and burning through.[23] Better results showed the addition of the oxide of uranium to the flux.

The filaments prepared of zircon and boricides quickly lowered their light efficiency and increased in consumption of energy in proportion. In an atmosphere of nitrogen or other indifferent gases the filaments burn through quickly and turn black from gray.

Alexander Juss prepares filaments out of nitrogen compounds of boron with the aid of an organic binder.[24] An alleged good mixture is 55 p. nitrogen compound of boron, 3 p. boron, 2 p. carbon, and 40 p. anthracite coal tar diluted with hot xylol. The mass is stirred till it turns sandy and pressed into filaments. A. Blondel[25] uses only the metal boron with an organic binder.[26] He also surrounds the filament with a mantle of a thorium-cerium mixture similar to Auer's gas mantle.[27] This idea is also applied to the arc light.[28] There was no deficiency in recommendations to prepare the carbon filament in an atmosphere rich in organic volatile compounds.[29] It was also suggested to use well conducting filaments surrounded by boron. As such were mentioned: Titanates, uranates, tungstates, and the rare earths (Zr, Th, Cc, La, Di, erbium, terbium, yttrium), gallium, alkaline earths Al, Be, Mg, etc. As boron was always applied with an organic binder, carbides were formed as soon as the metallic acid compounds reached their glowing stage.[31]

Carbide of boron is thought to be especially good for arc-light electrodes. According to the German patent 184706,[32] boric acid is reduced with aluminium at 230° C. in the known manner. The boron crystallized in the shape of needles melts with the carbon in the electric furnace.[32] The composition of the carbide of boron is supposed to be B_6C.[33] The following table shows the proportions in which the ingredients are to be mixed and the properties of the resulting carbons:

	Carbide of Boron. Per cent.	Carbide of Titanium. Per cent.	Carbon. Per cent.
Slowly consumed ..	20	60	20
Quieter, less light..	40	40	20
Quiet arc, short life	60	20	20

By reducing oxide of thorium according to Winkler's method in a carbonaceous atmosphere, carbon compounds of thorium are produced as in the case of zirconium. The particles of thorium are enveloped by a carbon shell. Owing to the high atomic weight of thorium a 2 per cent. content of carbon is sufficient to impart conductivity to a filament of any length. The conduction or passage of the current rather has the effect of shrinking the filaments to such an extent as to leave little of their original size or shape. The carbide of thorium is, as above mentioned, very unstable in its nature. This is the reason why experiments were conducted with a flux of nitrogen compounds of boron with carbon compounds of thorium. These filaments were very durable in the air, but non-practical. The patent on filaments from boricides[33] was therefore abandoned.

Although I did not succeed to prepare filaments from carbide of thorium, W. L. Voelker had more luck with the manufacture of filaments from the carbides of rare earths,[34] at least such is his claim. The nitrates of rare earths are turned into a paste with the aid of a cane-sugar solution, squirted into filaments and subjected to a glowing process. I must confess that my own experiments lead me to doubt the results of this process. Just as unsuccessful is an attempt to work up the nitride of thorium with the aid of an organic binder.[35] At the same time it appears that an

addition of thorium to other metals can by no means be condemned. Von Bolton, for instance, adds thorium or thorium-oxide to his filaments made of carbide of tantalum. Carbide of thorium is formed by the passage of the current through the filament with the aid of the excess of carbon emanating from the organic binder.[36] Corresponding carbides are likewise formed from the addition to the osmium paste of zirconium-earth, ytterium-earth, thorium-earth,[37] or the methol thorium.[38] The German patent 140503[39] of Siemens and Halske, according to which filaments are prepared of thorium with the addition of small quantities of carbide of thorium is based on the fact that so far nobody succeeded to prepare perfectly pure thorium and the carbide is always present as an impurity. The same fact undoubtedly led Kellner to apply for a patent for filaments composed of thorium with the admixture of some small quantities of the oxide of thorium.[40]

Emil Léon Fernot[41] applied the known method of conglomerating in an incandescent filament carbon with a conductor of the second class to a mixture of thorium with cerium, with the distinction that he added organic salts, for instance, tartaric acid salts, to the solution of the earthy materials to avoid the abstraction of carbon from the surface of the filament in the process of formation of carbides (which is only a device to get around earlier patents). The pharmaceutical institute of Lud. Wil. Lano uses a core of platinum instead of carbon and surrounds it with rare earths (Th, Zr, Ce, La, Di, Er) with the aid of oil of lavender. Carbides must be formed with the aid of the carbon emanating from the oil. The use of carbides of the group of rare earths in general (concerning Zr and Th, see footnotes 21 and 34-41) is recommended in the following patents:

H. Jehrlandt, German patent of July 13, 1899, issued October 9, 1900: The manufacture of electric glowing bodies. After impregnation with alkaline earths (?), treated with NaOH in order to form hydroxides. Alkaline earths (Ca, Br, Sr) as known give, however, no precipitates with NaOH just as with NH_3 (if the latter is free from Co_2). Another specimen of invention-activity in the realm of illumination!

Consortium for Electrochemical Industry G. m. b. H., Nuerenberg, and Dr. W. Nernst, German patent 178475 (Kl. 21) of September 10, 1905, issued October 15, 1906. The manufacture of filaments of a mixture of tungsten or alloy of tungsten and a conductor of the second class, especially rare earths This process has chiefly in view as the following the intimate mixture of the ingredients.

The same (except Nernst) German patent 184704 of February 15, 1906, issued April 2, 1907, supplement to 178474.

In the parent patent tungstic acid with rare earths is reduced in a hydrogen-atmosphere by heating. In the supplement is recommended the reduction of a mixture of the ingredients in molecular ratio in an iridium crucible with the heat of a oxy-hydrogen flame. The flux is then pulverized. Vanadium as a material for electric glowing bodies has also to be considered. Filaments of vanadium carbide were prepared in order to study the properties of that element. A durable (in the air) vanadium carbide is easily formed by fluxing together in an electric furnace calculated amounts of carbon and vanadium. The formula for this compound being VdC.

The filaments from carbide of vanadium conduct the current well, shrink little and uniformly so, and show a homogeneous structure in their outward appearance. Their color was metallic-gray and lustrous. Their mechanical strength was also favorable so that the filaments could be easily fused into the glass bulbs. The luminous efficiency at the start dropped only slowly, but soon the glass bulbs blackened from separated carbon totally. In order to reduce the carbon contents of the carbide of vanadium, the pure vanadic acid was fused without addition of carbon in the electric furnace, namely in hydrogen atmosphere, in order to avoid oxidation. In this manner a flux of vanadic material was obtained having only 5 per cent. carbon. This body was also very durable and workable into filaments. Unfortunately these filaments easily disintegrated into powder and blackened the glass bulb. It is consequently to be concluded that the unfavorable properties are due to vanadium itself, not to the carbon. According to the German patent of Siemens and Halske 158571,[42] glowing bodies are composed of the carbides of vanadium, niobium, tantalum with the admixture of Zr, Th and ytter-earth. The glowing bodies of R. E. Menges[43] also contain admixtures of the carbide of vanadium.

(To be continued.)

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Keep Trade At Home

Trade is as naturally attracted toward the large centers as is the earth toward the sun. The rapid increase in local transportation facilities resulting from the extension of interurban car lines has facilitated this concentration of trade to an extent that may well give the merchants of the smaller towns serious concern. This tendency for trade and population to concentrate into vast and overcrowded cities contains many elements of social and political danger. The larger the aggregation of human beings, the less does the individual count; and the suppression of individuality is always a menace to progress and national strength.

The gravitation of trade toward the larger towns cannot be overcome by mere protest and academic discussion; it must be met by setting up a counteracting attractive force. On what does the lure of the great city depend? Upon its more intense life, its appeal to the imagination, to the natural enjoyment of the spectacular, upon the mere aggregation of human beings. Man is above all a gregarious animal. His nature naturally abhors solitude. The smaller town that is to retain its trade and its general prosperity must cater to these universal human instincts.

The city whose streets are dark after night-fall will never be the gathering place of its own inhabitants. It is not the total number, but the proportionate number of people, that makes a throng. The smallest town can have thronged streets at night, as well as the largest city, if it makes its streets proportionately attractive; and the one thing that can do this is artificial lighting.

The days when the merchant pulled down his shutters at the close of business are passed. Closed shutters are suitable for only two events—death and bankruptcy. The brilliantly lighted store front is far more than a mere attraction for the individual merchant; it is an important component part of that general attractiveness which alone can keep the interest and trade of the citizens loyal to their own town.

Darkness is death, light is life. The town that would keep alive must make liberal use of artificial light; and the merchants who complain of the disloyalty of the citizen in seeking the larger centers must look well to their own efforts at making their stores in particular, and the town in general, attractive, before convicting their neighbors of disloyalty.

LIGHT UP, AND KEEP LIGHTED UP!

E. L. Elliott.

THE ILLUMINATING ENGINEER

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Window Lighting and Trimming

ANY adequate treatment of the subject of show window lighting must include a study of window trimming; in fact, the lighting is an accessory to the window display, which is the ultimate object. To properly trim and light a window is much more of an art than a science, and the illuminating engineer who would presume, therefore makes himself reasonably familiar with the artistic possibilities and limitations of window dressing. On the other hand also, the window dresser who would produce the best effects must study the problem of illumination carefully and analytically; for while a show window serves its purpose by day, it has come to be generally recognized that it performs its most valuable service, in attracting attention to the wares displayed during the evening hours when it is illuminated by artificial light.

A show window is somewhat similar to the stage of a theater; and the importance of the effects produced by light, and the superiority of artificial light over daylight for bringing out these effects, is universally recognized in theaters by the practice of excluding daylight entirely and using only artificial light in matinee performances. If, in arranging the lighting and the display in a show window, the idea of setting a stage so as to produce a vivid impression on the audience be kept in view, the results produced will never be far wrong. The prime object is to present a picture of artistic finish, bringing out the salient points vividly and impressvely and keeping the subsidiary or accessory elements in the proper subjection.

Show window display has grown to its present important position through a considerable process of evolution, and the really marvelous effects which are to be seen at the present time are due largely to the development of artificial lighting. Th old notion of the show window was to treat it simply as a place for disposing of various articles of merchandise and incidentally to give the passerby, who had sufficient interest or leisure to take the

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GAS
ELECTRIC
FIXTURES
THE NEW LIGHT
FOR NATURAL GAS
THIS HANDSOME LAMP

FIG. I.

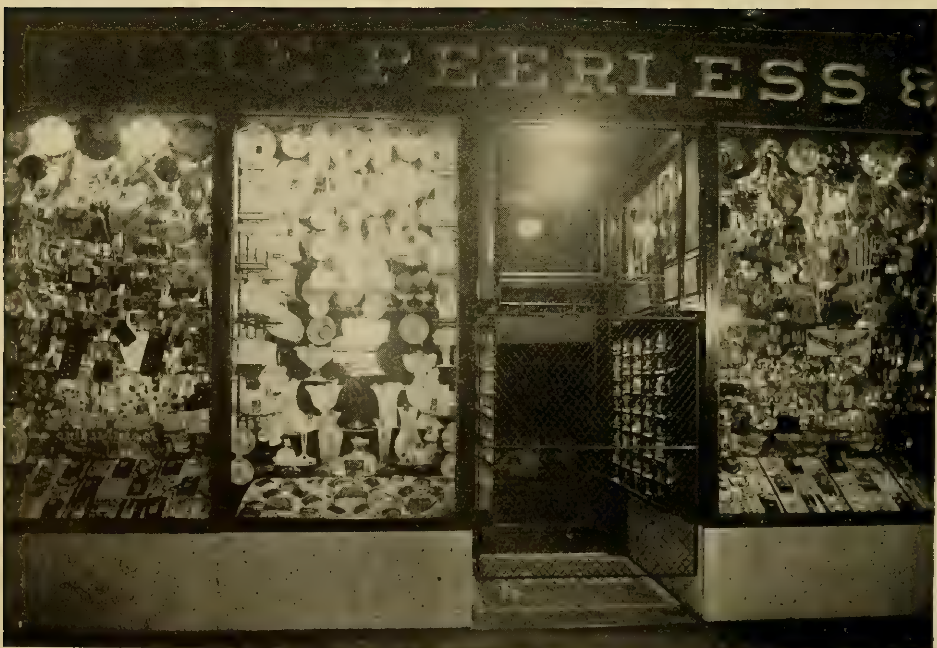

PEERLESS

FIG. 2.

trouble, to see what kind of wares was to be had within. This idea still prevails in small towns, and is not entirely extinct in cases where an actual effort is made at window display. An example of such a window is shown in Figure 1. This window occupies the entire front of a small store handling gas burners and other gas appliances. Some very commonplace chandeliers fitted with a cheap form of burner and shade are hung in the upper part, while burners, globes, pasteboard boxes containing mantles, gas stoves, and what not are piled in the bottom, giving the general impression that the stock room had been recently cleaned out, and the odds and ends dumped here for safe keeping. The lighting is by a couple of mantle lamps, without the slightest reference to the general effect of the illumination; but with such an arrangement, or disarrangement, the kind of lighting is of little moment.

Figure 2 shows another example of somewhat the same character. This is a store handling a general line of fancy articles, including cut glass, leather goods, jewelry, etc. The windows, as will be seen are fairly deep, and are filled from top to bottom, and from back to front with apparently every conceivable article that could be collected from the stock. As a result there is no distinct impression made upon the observer. It is difficult to clearly see any particular article except by getting close to the window and giving careful attention. It reminds one of an over-dressed woman, who has bedecked herself with her entire outfit of jewels, ribbons, laces and furbelows. The lighting is from lamps concealed in reflectors, and is much more brilliant at the top. The fault here is rather of the dressing than the lighting. Immediately adjoining this is the window shown in

FIG. 3.

FIG. 4.

Figure 3; and the difference in the general impression produced is at once apparent. Although the window is deep, the depth is used to give a perspective of the goods displayed rather than as mere space for their storage; the bottom of the window being utilized for the display of small articles. The lighting is from concealed lamps and reflectors along the front of the windows, which gives a practically perfect illumination on the goods at the rear of the window, even though extending near to the top: as will be observed, the illumination is remarkably uniform from top to bottom, and from front to rear. Altogether the display has a dignity and richness which is not only attractive, but suggestive of a high character of mercantile policy.

Figure 4 is a particularly instructive example of the importance of a careful consideration of the artificial lighting of a window. The window is large, and contains an exceptionally fine collection of works of art, which are arranged in a generally attractive manner. Owing, however, to the numerous bare electric lamps in the store behind the window, and even on fixtures in the window itself, the picture effect is entirely obliterated, and the eye catches only the glare of these numerous brilliant points of light, giving much the same effect as that produced by a sudden blow on the head. It is only by standing close to the glass and shading the eyes with the hand that the articles in the window can be properly seen. The only remedy in this case, barring a complete change

FIG. 5.

in the illumination of the store, would be to curtain the back of the window, either with a dark opaque shade, which could be pulled down at night, affording a dark background which would set out the display in relief, or by using some light-colored translucent fabric.

In contrast to this the window shown in Figure 5 may be cited. Here the illumination is by concealed lamps at the top and front of the windows, and the display so arranged as to receive practically uniform illumination. The goods are tastefully arranged, and stand out in brilliant detail like a well cut cameo. The windows would attract attention from the opposite side of the street, or in fact as far as they could be seen.

Figure 6 is an exaggerated case of an attempt to produce an artistic effect, but with a failure to recognize the most elementary principles involved in the art. The store front is an exceptionally handsome and expensive one. The ceiling and floor of the windows is paneled in beautifully finished walnut and the sides and back are hung with dark colored draperies. On the four corners of each ceiling there are clusters of four lamps enclosed in glass bead globes, and between these corner clusters are distributed single lamps, likewise with beaded shades. In themselves the bead work fixtures are very pretty, but as a means of lighting the window it is difficult to conceive of a worse device. The photograph shows that the illumination is entirely inadequate in point of intensity. The dark colored garments at the left are indistinct, and as a whole the window presents a picture that is flat and unimpressive. The ceiling lights, by their

FIG. 6.

conspicuousness, absorb any attention that the window might attract. The dressing of the window has been well done, but the effect is entirely lost by reason of the poor lighting. This fault can be corrected by installing some form of tubular lamp in a very small trough reflector in the upper

FIG. 7.

front corner of the window, and along the entrance, and by removing at least the individual lamps and globes from the ceiling. If the goods displayed were brilliantly illuminated the corner clusters might be left for their decorative effect.

One of the most difficult problems in window trimming and lighting is that presented by furniture stores. The goods to be displayed are large, requiring a correspondingly large amount of window space, and are generally dark in color, and require careful selection and arrangement to avoid the junk pile effect. Figure 7 is an example of a misguided effort at a window display of this kind. The conditions here are favorable; the window is large and the line of furniture carried by the house is of the highest grade. The trimmer has done his work with excellent taste, giving the effect of a furnished room rather than a display of samples; but the lighting could scarcely be worse. The shades shown are simply huge Japanese parasols of a dark colored paper, beneath which is a cluster of bare electric lamps. The illumination is entirely inadequate in intensity, as the photograph shows, and the glare of the lamps highly objectionable. The usual method of concealed lamps in the proper reflectors at the front upper corner of the window would give the desired results.

Figure 8 is an example of a furniture store window in which the right principle has been used, but not properly carried out. Back of the upper portion of the window on which the sign is painted there are bare electric lamps; shades being avoided evidently

FIG. 8.

FIG. 9.

in order to show the transparent letters of the sign. If these lamps were fitted with prismatic reflectors they would considerably more than double the illumination on the furniture and still give enough light to illuminate the transparency. The table lamp is a very acceptable addition to the general lighting.

The window of a piano store offers the same general difficulties. Both the dark color of the piano case, and its high polish, contribute to the difficulties of the problem. Figure 9 shows an example of a complete failure to overcome these two difficulties. It requires very sharp scrutiny of the picture to discover that there is an upright piano in the rear of the window. A cluster of bare lamps under an opal reflector is suspended in the middle of the window, which gives a hopelessly cheap look to the whole effect, besides failing to give the necessary illumination. Bare lamps otherwise disposed in the window are so reflected in the piano case as to obliterate the outline. A mistake has also been made

FIG. 10.

in attempting to display sheet music and other articles in the same window.

Figure 10 is a most agreeable contrast to this faulty installation. Here the entire window is given up to the display of a single grand piano. The view of the store within discloses only plain walls. The back of the window is draped with a light green crêpe, which given an exceedingly pleasing harmony with the dark mahogany of the piano. Furthermore, the light background makes the instrument set out in striking relief. The lighting is by concealed lamps at the front and side of the window, and so placed as to give no direct reflection in view of the observer. The whole effect is that of a well composed work of art.

Figure 11 shows the window of a music store displaying sheet music and small instruments. Except for the fact that some of the reflectors have been allowed to sag, the lighting is excep-

FIG. 11.

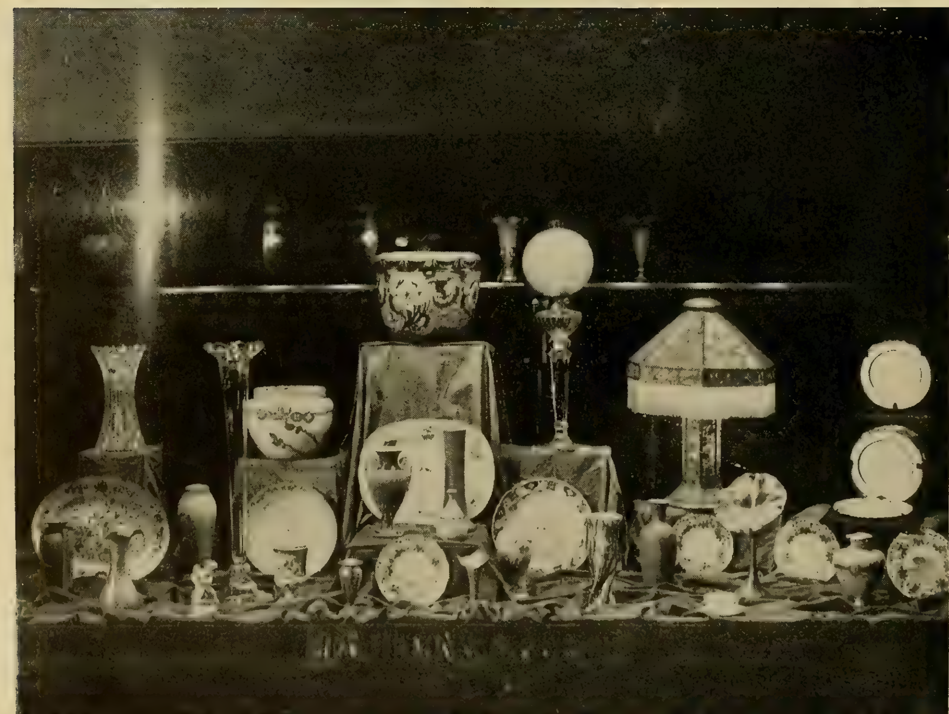


FIG. 12

tionally good. The exact symmetry of the sheet music is relieved by the carelss position of the instruments.

Figure 12 is a fine example of the picture effect in window lighting. The articles are well chosen, and not too numerous. The background and drapery furnish a pleasing setting. The peculiar cross-shaped light at the upper left hand corner is the reflection of an arc lamp suspended at the curb near the window. The phenomenon is interesting scientifically as showing the fact that even the highest polished plate-glass surface is in reality simply a mass of scratches, which are brought out by the intense rays from the arc lamp at the particular angle of direct reflection.

Figure 13 is another example of the successful treatment of a window so as to produce the picture effect. The lighting here is all concealed, and the goods displayed are brought out by a uniform and fairly intense illumination.

Figure 14 is another example of the same kind with another class of goods.

A point very apt to be overlooked in window lighting is that the intensity of the light produced must vary with the reflecting power of the goods shown. This is particularly important where different classes of goods are exhibited in adjacent windows, as in the case of large department stores. Thus, if white goods, and men's clothing, which is usually of a dark color, are shown in windows with exactly the same intensity of light the white goods window will appear brilliantly illuminated, while the clothing window will appear dark. This is shown in Figure 14, in which the windows all receive the same amount of light. In such cases provision should be made for varying the intensity of the light in different windows. This may be done either by installing a large number of sockets fitted with the ordinary sized lamps, and using more or less according to the character of the goods

FIG. 13.

FIG. 14.

displayed, or where this has not been done, higher power lamps may be used for the darker colored window displays.

The background of the window is another point that requires due consideration. Remembering that the object is to make the goods conspicuous,

FIG. 15.

FIG. 16.

i. e., to stand out distinctly, the background should furnish as great a contrast as possible. Figure 15 shows this principle worked out in an admirable manner in the window of a shoe store. In this case the background is of a very light color the supports of the shoes are slender and as inconspicuous as possible, and the illumination brilliant. It is easy to conceive that a dark background here would have ruined the whole effect. It should also be noted in this case that the use of a large number of lamps outlining the canopy over the entrance does not detract from the impressiveness of the show window display. Without this brilliancy and distinctness in the show windows they would have been entirely eclipsed by the dazzling brilliancy of the outlining and the sign.

Figure 16 illustrates a faulty method frequently used of outlining the window itself with bare lamps. The hazy appearance in the picture exactly represents the effect of glare produced upon the eyes in looking at the window itself. There is just the difference between the effect produced by a "foggy" photograph, and one that is "brilliant."

Show Window Lighting by Gas

By T. J. Litle, Jr.

THAT the up-to-date merchant has placed a higher standard upon his show window illumination is a fact that cannot be disputed, and recent practice has been moulded directly by the merchant's demand for higher illumination and more effective distribution.

Window-dressing has become an art; high salaried individuals are retained by all the leading concerns in the country, who make it their business to effectively display the goods to the public. The store window is also recognized as one of the most valuable advertising mediums.

With such a valuable asset therefore at his command, the merchant turns his attention to the proper lighting of the window. The engineer who had laid out the lighting of the building simply arranged for what he imagined to be the proper number of outlets and the location in the show window. Sometimes he gives this matter a great deal of thought, with the result that good lighting is obtained, but more often the results are quite the contrary.

We are all aware of the fact that a white goods display is more effective in most of our shop windows than dark goods. The only way to overcome this difference is to increase the light source, and this is being done. I believe that the illumination in the store windows will have to be gradually further increased on account of being compelled to compete with the powerful light of the flaming arc lamps, which are being quite generally used in our larger cities, and a show window at night, if it is to have any advertising value to the merchant must stand out in bold relief to the passerby, and it requires powerful illumination to accomplish this end.

With this great demand for increased illumination, the question of economy becomes a prominent factor. The shopkeeper is frequently confronted with the fact that his lighting bill is almost as much as his rent, and as it is becoming the practice to leave the lamps in the window burning until late in the evening for advertising purposes, the problem is indeed a serious one.

Taking all these things into consideration, I am of the opinion that this matter of economy is going to be uppermost in the minds of our merchants; they will experiment to determine for themselves which system will give not only the best illumination but which can be produced at a reasonable cost.

During the past year great changes have been wrought in show window lighting, both in the use of gas and electricity. The progress has been most marked, however, in gas lighting, due to the successful application of the inverted incandescent gas burner. Even to the lay mind it is at once apparent that this type of burner is admirably adapted to store window lighting on account of the great downward light and the ease with which it can be applied to all existing conditions.

There is no doubt but what the quality of the light given by the inverted burner is superior to the upright type of burner, inasmuch as the mantle is raised to a higher incandescence in the

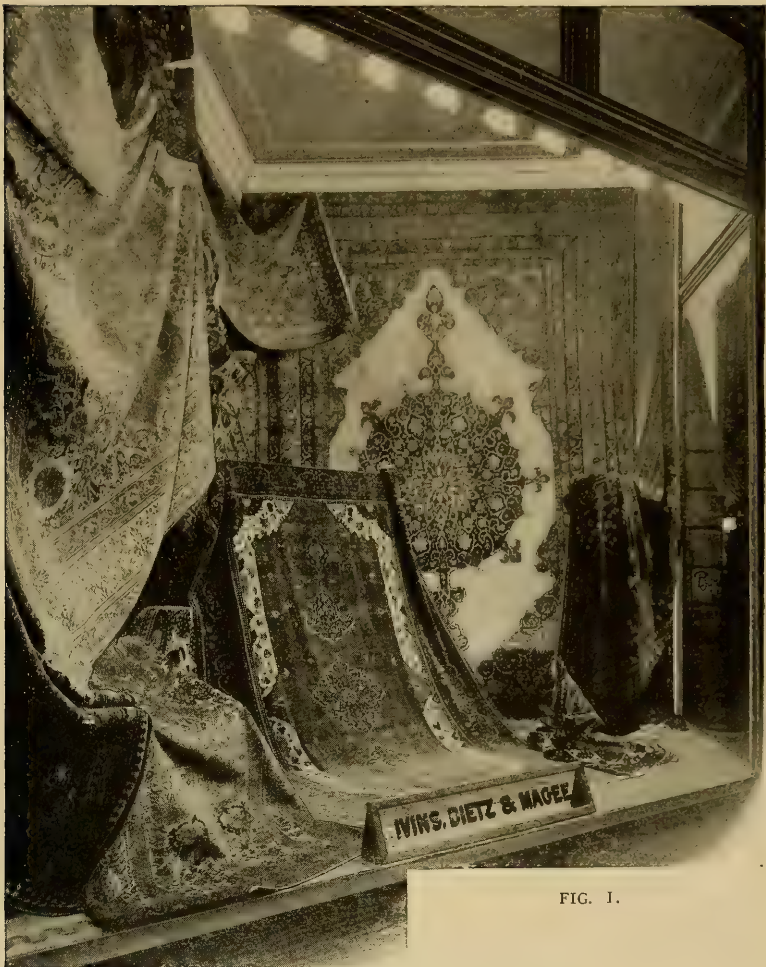


FIG. I.

former case, producing at the same time a powerful, mellow-white light of great intensity.

The construction of the inverted burner is such as to allow the gas piping to be above the burner and out of the field of illumination, which is not the case with the upright burner, and this proves particularly advantageous not only in the deck lighting (described later on) but also in open window lighting.

The inverted mantle is in itself much stronger and more durable than the upright and this coupled with its great efficiency and high intrinsic brilliancy has at once placed it in the front rank of artificial illuminants for show window lighting.

Show windows may generally be classified under the following headings:

Open Window Lighting, in which the lamps are hung directly in the window.

Deck Lighting, in which the window is sealed and lighted from above a transparent or translucent deck or ceiling.

Windows lighted from the outside of the building.

In lighting show windows it is well to have the lamps so located that they will be out of the normal range of vision.

Nothing is considered more atrocious in store window lighting than to stud the sides and back of the window with lamps. Such an arrangement tends to distract attention from the goods on exhibition, and seems to be intended to impress the observer with the fact that the shopkeeper is squandering his money on poor lighting.

The following photographs illustrate show windows in various parts of the country, and serve to indicate how widespread is the movement toward this new system of lighting. All the large cities now contain hundreds of similar installations, and the practice has spread to the smaller towns.

Figure 1 shows the Open Window Lighting type. The lamps are hung high and are equipped with No. 445 angle reflecting shades, which throw the light downward and well back into the window. The distribution in this case is well defined, as may be seen on examination of the handsome oriental rugs displayed. It will be noted that the upper portion as well as the central lower portion of the window is perfectly lighted.

The lamps are ignited by means of the Independent Pilot System; that is, a separate gas line is run which supplies a small pilot flame for each burner. The supply line for the burners is controlled separately. The lamps in this installation are burned

FIG. 2.

until 10 o'clock in the evening, when they are extinguished automatically by a time-clock shut-off, which has been specially constructed for use in connection with the inverted burner system of window lighting.

This photograph was taken by the light from the lamps at 9 o'clock in the evening; exposure, about 12 minutes.

Figure 2 shows window equipped with No. 505 mirror glass reflectors. The ceiling of the window being quite high, it was possible to use mirror glass reflectors to good advantage—the lamps being out of the field of vision, bringing the display into relief without objectionable glare. It will be noted that the lamps are arranged in two rows, which distribute the light very uniformly over the entire window, the front row throwing the light well ahead of the price cards, the back row taking care of the rest of the window. The background in this case is formed of a peristyle, finished in Flemish oak. The goods exhibited also being quite dark, demanded very powerful illumination. The cost of lighting this window, which, by the way, is considered one of the best lighted windows on Chestnut street, is not over 4 cents per burning hour.

The lamps are lighted by the Independent Pilot System.

Figure 3 shows what can be done with deck lighting. This window is lighted by the inverted burner system, the lamps being placed above a deck, with panels of ground glass. The distribution is wide enough to cover the entire display, and this method of construction enables the window to be completely sealed, thus protecting the goods from the dust. The window is lighted with twelve inverted lamps, equipped with 505 mirror glass reflectors. They are lighted by a separate pilot line.

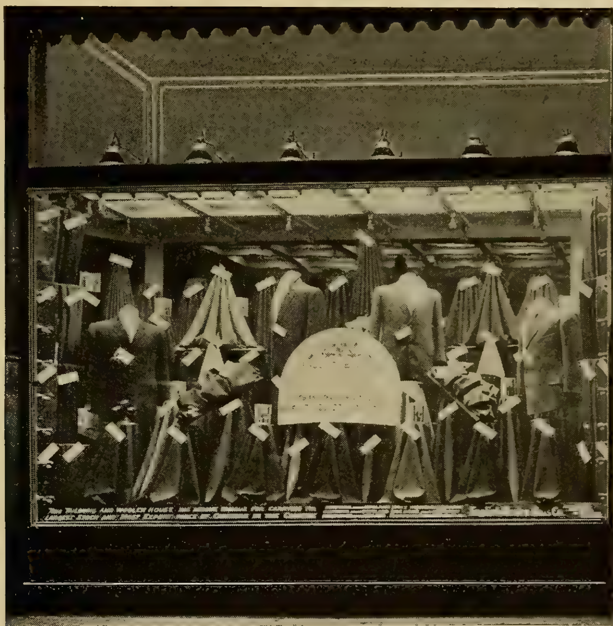


FIG. 3.

Figure 4 also shows a window equipped similar to the one just de-

FIG. 4.

scribed. In this case, however, the border of the window above the deck has been blocked out with an opaque background with transparent letters to form an illuminated sign without additional cost.

The equipment shown in Figure 5 is inverted lamps with No. 445 green plated angle reflecting shades.

This is a case where the objection commonly raised to gas lighting has been overcome by an electrical jump spark arrangement, by which it is possible to light the entire installation by simply pressing a button. A clock cut-off attachment is used for extinguishing the lamps at any pre-determined time.

The interior of the store is also lighted with inverted lamps, equipped with No. 442, 5 inch ball globes on inverted chandeliers. This picture was also taken at night by the light of the lamps only. Exposure about twelve minutes.

This electric jump spark device is arranged in the burner in such a position that the gas is ignited instantly. The system depends for its operation upon the principle now so successfully utilized for sparking the gas mixture in all automobiles and gas engines. The spark comes from the secondary terminals of a small induction coil. The primary current is supplied by six standard dry cells. A set of these cells will last about one year.

The foregoing views will serve to illustrate the wide spread growth and application of the inverted gas lamp for window lighting.

The flexibility of the system permits of its application not only to large city

contracts, but to the small shop in every gas consuming community in the country. Existing installations of various types serve as working models which may be applied to almost every field of store window illumination.

When it is considered that these wonderful transformations in window lighting have been brought about by the introduction of a system which has no competition from the standpoint of economy and cost of operation, it will be conceded that this new and exceedingly fertile field offers an unusual opportunity to the gas man.

Store Lighting With Enclosed Arc Lamps

By G. H. Stickney.

MANY store managers are considering the rearrangement of their artificial lighting to keep up with the progress of the times. The experience of the past few years has produced considerable improvement in the effectiveness of fixtures, while the investigation of refractory materials has resulted in more and more efficient lighting units. With the advent of the Tungsten filament, a clear incandescent lamp has attained an initial efficiency practically equal to that of the enclosed arc lamp as commonly used.

On account of the change in conditions many are in doubt as to what is the most suitable system for store lighting. As a matter of fact, no one system is suitable for all conditions; a practical study of each case is necessary in order to determine. There are certain classes of stores where the Tungsten lamp will rival or surpass the enclosed arc, particularly in small rooms with low ceilings. On the other hand. there are conditions in which the arc lamp is not only more effective but more economical, especially where it is possible to utilize modern forms of diffusing apparatus. It should be borne in mind that both the efficiency and color of light of the enclosed arc lamp improve with increasing current. For example, the 6½ ampere direct current and the 9 ampere alternating current enclosed arc lamps are much more efficient than the 5 and 6 ampere lamps corresponding. The color quality of the light from the high current lamps is slightly warmer, or more yellow in tone. than the average daylight. Such lamps can be used effectively in stores having a fairly high ceiling, say fourteen feet or higher, especially if the store is of modern construction and can be divided into sections, say eighteen to twenty-five feet square.

When so used this system has some of the following advantages over other available lighting systems: The color of the light approximates more closely to average daylight than any other, and is therefore best suited to supplement daylight. It further shows materials more nearly their true daylight color and can be better relied on for careful color selection and matching. Lamps can be located high so as to avoid fixtures hanging down and cluttering up the store. This arrangement also avoids the glaring effects and spotted illumination which are tiring to the eyes and distract the customer's attention from the merchandise. The illumination from large, well diffused sources may be likened unto that from skylights; it is at the same time soft and even, yet brilliant, without harsh contrast or dense shadows.

When the cost of the illuminating of a store for a year is carefully figured, making allowance for depreciation and interest on the investment, the best arc lighting systems always compare favorably in economy with any others, and usually show considerable advantage. The cost of current and maintenance are relatively low, while the first cost is not excessively high. In nearly all cases with any system the cost of installation is less than the cost of a year's operation.

An excellent example of a well-illuminated store is illustrated in the accompanying photograph taken on the

first floor of the new C. C. Desmond store in Los Angeles, California. The illustration is from an untouched negative by Putnam & Valentine, Los Angeles, taken entirely by the artificial illumination. The photograph shows the even distribution of light and the absence of dense shadows.

The Desmond store is devoted to the sale of clothing and men's furnishings and is the largest and finest store of its kind on the Coast. It has a ground floor area of about 14,000 square feet, and is finished in Flemish oak with a warm orange yellowish ceiling, the height of the ceiling being about 16 feet.

After making a thorough trial of the system in the section shown in the cut, Mr. Desmond is having it installed in the remaining sections of the first floor. The final installation will comprise twenty-six lamps. Mr. Desmond considers that he has one of the finest and best-lighted stores in the country.

Notes on Some Western Installations

By George Wilfred Pearce.

In Pittsburg, Wheeling, Louisville, Cincinnati, Cleveland, Columbus, Indianapolis, Chicago, Detroit, Milwaukee, and a number of other western cities, recently visited by the writer, architects and engineers of commercial and public buildings are breaking away from the old schools of window design which made them conform to the sizes in use before steel skeleton construction became general. In a number of new buildings in the above-named cities retail and wholesale commercial buildings are going up in which the wall space allows 80 per cent. for windows. In several very large buildings the window space takes 85 per cent. of the wall space. The result of the enormous area of window space has brought about the best possible conditions for illuminating engineers to exercise their genius and learning in designing attractive fixtures. A number of these buildings in the finest retail streets of these cities are strikingly beautiful when daylight has gone, resembling a gigantic lantern whose enormous globe is paneled into divisions—for so the floors appear to the beholder.

The proprietors of a large retail furnishing goods building, fourteen stories high in State street, Chicago, informed the writer that when they decided to reconstruct their building so as to have as much window space as possible, they thought only of the daylight illumination of the place; but when they opened the establishment for the first day the daylight trade was not strikingly above the average in the old place, but when the hour for artificial illumination came the store began to fill up in a surprising way, and the streets were blocked by thousands who admired the scintillations of the myriad of lights which made the establishment a palace of light. So it has been ever since. In scores of old buildings shopkeepers have had the old style windows taken out and the largest windows put in that the structure will carry. Then follow elaborate window and ceiling fixtures, and the generous use of gas or electricity. In a number of small western cities in which the city fathers show cheese-paring economy in appropriations for street lighting, storekeepers and others possessed of a high degree of civic pride, are keeping their shops well lighted all night for the benefit of the public; and the same is the case with a large number of manufacturers who keep their outside lights going all night for the public good.

A few days ago the real estate owners of the most of Dearborn street, Chicago, one of the principal down-town streets in Chicago, held a meeting to take counsel as to the best ways for making the thoroughfare more popular with those who want offices and stores in busy down-town streets. All sorts of ideas were broached for "booming" the street, but not one of the ideas elicited any enthusiasm, until a clear-eyed and shrewd real estate owner arose and said that he had spent many days and nights walking about the city trying to find out why it is that two streets that run the same way as Dearborn are filled with throngs, and all the shops and offices are alive wth people, while old Dearborn street is just as it was years ago. He said: "Gentlemen, I have come to the conclusion that what we must have to enliven our street is plenty of artificial illumination. Ours is one of the darkest streets down town after sunset. The city will not help us in this way. We must go ahead and provide as fine a display of

outdoor illumination as we ought to have, and when that comes about, we shall see a great change for the better. I have talked with upward of a thousand people in this neighborhood about the best way to improve Dearborn street, and they all say, 'Give us plenty of street lights.'" The result of the meeting was that a sum of money was voted to pay for street lighting, and illuminating engineers were called on the next day to prepare report on the best method of lighting.

The proprietor of one of the most beautiful restaurants in Chicago told me that a while ago he went to enormous expense to have a large banquet hall built in medieval German style. His architect, one of the best in the city, advised the proprietor to light the hall in a dim manner, so that everywhere deep shadows would lie, as in old baronial halls. The architect thought that the refined people who would patronize the place would like a "dim religious light." But he was mistaken. The place was so dark by day that it was gloomy, and at night the vast place had a funeral aspect that seemed to chill the guests. Many patrons of the proprietor's old place, which is well lighted, came to the new place but once or twice, and were seen no more. The architect was called in. Like the clever man he is, he said, "I am mistaken. The medieval lighting idea will not go in the Twentieth Century. Our people want plenty of light to bring out the beauties of ladies' dresses and to impart that cheerful feeling which abundance of light imparts. I have made the mistake of my life. The only thing to do to set everything right is to call in illuminating engineers and let them design an installation that will charm away dull care and excite to good cheer at the table." Within six weeks the illuminating engineers put in fixtures that made the place one of the most attractive in the country, and at evening it is thronged with the best livers in the city.

One night while in Chicago, an illuminating engineer took me to see one of the best designed and installed examples of gas lighting engineering in the West. The church is in LaSalle avenue, at the corner of Elm, and is a very beautiful structure, decorated in the highest form of art, and is attended by a congregation of superior people. A finer example of well-studied gas engineering does not exist. Every part of the edifice is equally well lighted. There is just the proper amount of light and no more. The fixtures are chaste and of the right proportions and are so made as to be properly subordinated in the body of the church to the magnificent candelabras and sacramental lights which are in the sanctuary. In going from that church, the writer was taken to see a fine arrangement for lighting a great tent, holding four to five thousand persons, that is used for gospel meetings in North Clark street. There are no fixtures. The several thousand lights are festooned and strung about tent poles and on lines of wire. There is sound engineering knowledge and good taste displayed in the installation. The engineers have not placed the lamps where the light would dazzle eyes, and they have given plenty of light where it is wanted. The evangelist in charge of the meeting said that the handsome but inexpensive lighting of the tent had high value as an agent in attracting people to the meetings, and that he had noticed wherever he had worked, that just as soon as churches and gospel tents are properly lighted, it makes one of the attractions that draw people to the meetings.

Quality of Illumination from the Merchant's Viewpoint.

By George Loring.

Many business men of to-day have considered the so-called quantity and efficiency of light necessary for the several purposes about their establishments. In this respect they have the goods shown therein, the display windows and contents, as well as certain sections of the sidewalks surrounding the premises and portions of the outside of the buildings themselves. The question of quality of illumination has been given very little thought. The chief reasons for this are the comparative sameness of colors emitted by the electrical illuminants in use during the past twenty-five years, and the low efficiency obtained when artificial methods were employed to change the color effect. The regular commercial arc lamp has always delivered a light in which blue predominates, while the rays of carbon filament incandescent lamps have never deviated from orange-yellow.

Recently there has been introduced the Tungsten illuminant. The quality of illumination from this new lamp is a subject of the utmost importance; it resembles that of the sunlight, and gives to all colors their true values. It is a well-known fact that carbon lamps cause white goods to appear a trifle yellow, materially change nearly all other colors, and produce at times disagreeable shades and tints. The same may be said in a general way of arc lamps, excepting that they produce a blue effect upon white.

Practically all stores have their window dressing done at night; and the light of day invariably produces a material change in the color scheme of the goods displayed. If the window decorating is done during the day time the result is simply reversed when darkness sets in. The white rays of a Tungsten lamp eliminate this most troublesome difficulty.

Everyone buying or selling materials in which shades and tints appear should hail the Tungsten lamp with delight. The purchaser need no longer give himself inconvenience in order to obtain colored goods during daylight hours; stores will have less dissatisfied customers; the number of exchanged goods will be decreased; business will be increased because of less time necessary in making sales and fuller working hours each day in which to make them; and selling expenses will naturally be lessened.

In a hundred-and-one ways it appears that the matter of quality of illumination is most important, and quantity and efficiency are often questions of secondary importance. The Tungsten lamp, however, is extremely efficient. It requires never more, and oftimes less than 40 per cent. as much electrical energy as a carbon filament lamp producing the same quantity of light. In other words, a man who now has an illuminating bill of $100 per month for store lighting with carbon lamps, could generally reduce this to $40 per month by installing Tungsten lamps, and at the same time greatly improve the illumination in the majority of cases.

There are undoubtedly a few cases in which goods should not be shown under the white rays of the sun or the Tungsten lamp. Take as an example Turkish rugs, antique furniture, ball dresses, etc. An orange-yellow light with a shading of red furnishes a very good illumination in which to show them; it softens the appearance of the rugs and causes the furniture to be seen as it was fifty years ago.

Theory and Technology

Plain Talks on Illuminating Engineering

BY E. L. ELLIOTT.

XIV. Store Lighting

FROM the wigwam of the aboriginal Indian, in which skins and primitive articles of handiwork were bartered for the trinkets of the white man, to the department store of the present day, with its acres of floor space containing every conceivable article of merchandise gathered from the four quarters of the earth, there is a span which bridges the entire commercial progress of the world; and the difference between the light of the pine torch, and the brilliant illumination of the modern mercantile palace measures the advancement of science in a similar manner. Under modern conditions the artificial lighting of a store is the most important adjunct to the business of merchandising. When it is considered what a large part of trade is of a transient nature, and that the first necessity in obtaining such trade is to entice the purchaser into the store; to how large an extent the artificial lighting determines the general attractiveness of both store and goods; to what an extent the appearance of merchandise influences the buyer; that this appearance depends very largely upon the lighting; the importance of the illumination will not be doubted.

The general conditions to be considered in laying out the lighting installation for a store may be included under the following heads:

1—Intensity of illumination on some assumed plane.

2—Color value of the light.

3—Size of units

4—Location of units.

5—Decorative features.

6—Special lighting for special purposes.

7—First cost of installation.

8—Cost of operation.

9—Cost of maintenance.

INTENSITY OF ILLUMINATION ON SOME ASSUMED PLANE.

In most cases the assumed plane will be the top of the counter; in some cases it may be a vertical place extending to a height of six or eight feet, as in the case of tapestries and goods that are hung up for display, while in other cases it may be the floor, where carpets and the like are displayed. The intensity at counter height will, of course, vary with the

class of goods handled. For example, leather goods, men's clothing, and other dark colored merchandise will require more than twice the amount of illumination necessary for white goods and light colored fabrics. A range of from two to five foot candles would fairly cover this difference. Where such different classes of merchandise are sold in the same store, and particularly in the same room, this difference in intensity in illumination should be provided, if possible; if an illumination of five foot candles is provided for dark goods it will be better to reduce the intensity on the lighter colored goods, otherwise there will seem to be an appearance of gloom in going from the light to the dark colored goods departments. Tapestries, wall papers, and the like, which are displayed in a vertical plane, are usually of a non-reflecting quality, and will require the higher intensity. Pictures and art displays may be more properly considered under the head of special lighting. Floor coverings will require the greater intensity, for the reason that they are usually dark in color, and non-reflecting. Furniture may be classed under the same head. In small stores where miscellaneous merchandise is handled, an average between these two intensities, say of three to four foot candles, may be used. Excessive intensity is to be avoided, as in many cases it will give the goods a somewhat different appearance from that which they will have under conditions of use, and thus give the buyer grounds for assuming that he has been deceived. Insufficient intensity is simply an inexcusable failure to properly show merchandise.

COLOR VALUE OF THE LIGHT.

No feature of store lighting has received so much attention within recent times as the question of color. This has arisen from the great difference in color values of modern light-sources. The general subject of color is complicated, and rests upon abstruse laws and theories. It remains for illuminating engineers to sift out the most practical considerations, and put them into practice.

So far as general effect is concerned, the colors of artificial light may be divided into three classes:

First.—Warm, or mellow.

Second.—Neutral, or white.

Third.—Cold, or hard.

Taking the neutral, or white tone of which diffused sunlight may be taken as the standard, the "warm," or "mellow" tones are those containing a greater amount of red or yellow rays; and the "cold," or "hard" tones are those containing a greater amount of blue or green rays.

Light sources giving warm tones are: Flames, incandescent electric lamps, mantle gas lamps (except from old or inferior mantles, which give a green cast), Nernst lamps, Moore tubes ("normal") and flaming arcs ("golden").

Sources giving cold, or hard tones, are: Unshades arcs (particularly the enclosed arc).

Sources giving neutral, or white tones are: Acetylene flames, metallic or "luminous" arcs, flaming arcs with special carbons, Moore tubes (using carbon dioxide), and the new metallic filament electric lamps.

Generally speaking, it is better to display goods under the same quality of light that they will be seen when in use, and this is either the neutral light of day or the warm tone of flames, incandescent electric lamps, or the slightly yellower tone of mantle gas burners. In no case is a cold or hard light preferable to either a neutral or a warm light; but there are cases in which it is not objectionable.

FIG. 1.—SPECTACULAR LIGHTING; BAD FOR SHOWING GOODS.

FIG. 3.—FURNITURE STORE LIGHTED BY INDIVIDUAL LAMPS; A GOOD METHOD.

such as in stores handling hardware, groceries, and other staples in which the color of the light is immaterial. On the other hand, there are very few if any, cases in which a neutral light will not be satisfactory, as there are few classes of goods that are not seen to a greater or less extent by daylight. An exception well worth mentioning includes colored fabrics used for evening dresses. The extreme delicacy of shades and tints produced by modern dyeing, together with the peculiar absorption which the aniline dyes and certain textures produces renders this case one of considerable importance. Tints that would produce a harmonious combination by daylight may very readily give a discordant effect by ordinary artificial light. Furniture and house furnishings in general are rarely seen by brilliant daylight in use, and are mostly viewed under artificial light of a mellow tone; hence the advisability of using a similar illumination for their display in the store. Men's clothing seldom involves any but dark colors, the prevailing shades being either blacks, or modifications of black, gray, or the warm shades of brown. Neutral or white light is, therefore, not necessary for their proper display, since they will have their normal appearance by a light of warm tone. Millinery goods furnish a case where it is essential to have a neutral or white light, since they include a great variety of colors which in use are seen principally in daylight. The proper matching and blending of these colors can, therefore, only be satisfactorily done under a light of daylight quality.

The color of light-sources may be modified within certain limits by reflection, and by transmission through transparent or translucent media. In either case the modification in color is produced by the absorption of a part of the rays, and consequently is always productive of loss in the resultant illumination. In many cases the loss necessary to produce neutral light is so great as to render the process impractical. For example, the warm light of a gas flame could be made neutral or white by absorbing the excess of yellow and red rays by the use of greenish blue glass globes, but the light thus absorbed would be so large a part of the whole that the remaining white light would be comparatively insignificant. It is, of course, impossible to introduce any new rays into a light by either reflection or refraction. It is thus impossible to produce even approximately neutral light from the mercury vapor lamp, for the reason that its light contains practically no red rays. Light-sources which have a preponderance of blue and violet, as the arc lamp, however, may be very readily modified so as to give a neutral tone by absorbing the right proportion of these blue rays. This is most easily and successfully done by the use of an opalescent glass of the right density and composition; such glass is of an orange-yellow color by transmitted light, due to its selective absorption of blue and violet. Arc lamps thus equipped, therefore, furnish the most practical means at present of supplying neutral illumination. The acetylene flame gives a practically perfect neutral light, that is, of daylight value; but for obvious reasons its use in stores under present conditions would be impractical in the majority of cases. The Moore vacuum tube light, using pure carbon dioxide, also gives a perfect neutral light; but this is apparently not yet commercially available. The new metallic filament lamps give a close approximation to neutral or white light, and will undoubtedly come into large use when they are further developed. Mantle gas burners are properly classed among the warm-

A large drug store lighted with 4-glower Nernst lamps and 8-inch Holophane globes. The photograph was taken by the regular illumination, and has not been retouched. The lamps themselves are naturally obliterated by the halation, but the goods displayed both in the counter cases and wall cases show up remarkably clear. Observe that there is absolutely no reflection of light-sources either from the glass doors of the wall cases nor the glass forming the show-cases.

toned light-sources, although their color is distinctly yellow instead of orange, as in the case of gas flames, the yellow verging toward green. The Nernst lamp is substantially similar in color to the light from the best quality of mantle gas burners. It is impractical to produce neutral light from either by the use of colored glass globes. The light of mantle burners, however, can be successfully toned to harmonize with the warmer light of flames by the use of a peculiar light rose-tinted glass, which is unfortunately unknown in the general trade. The color of light can be modified by reflection from tinted surfaces, but this is far less efficient than by transmission. The new metallic or luminous arc lamps give a neutral light, as do also the flaming arcs using specially prepared carbons; but in both of these lamps there are certain fumes generated, and they have not as yet been used to any considerable extent, at least, in this country, for interior lighting.

SIZE OF UNITS.

So far as distribution of light is concerned, equally good results can be obtained by units of any size. The question of size is, therefore, one of either personal taste or cost of installation. A "unit" in this case is to be understood not necessarily as an individual light-source, but one or more sources with their accessories comprising a single fixture. It is probably a safe rule that the size of the

Exterior view of drug store showing the window illumination, including the transparent signs at the top. The lighting is by 4-glower Nernst lamps, and is an excellent example of both attractiveness and efficiency in store lighting.

unit should bear some relation to the size of the space which is to be lighted. Large units look out of place in small spaces; for example, arc lamps, either gas or electric, in small stores; while on the other hand, a large space, like the floor of a modern department store, would present a better appearance wih larger units, even though consisting of several light-sources clustered in a fixture, than with the same sources scattered about the ceiling.

LOCATION OF UNITS.

As in other cases of lighting, the location of units will generally have to be a compromise between structural conditions and considerations of distribution of the light. The most advantageous point for the latter may not be possible under the former. Thus, a large ceiling divided into panels or bays necessitates the location of units symmetrically placed with regard to the structure. Ceilings usually are, and always ought to be, either white or a very light tint, thus forming a surface which will reflect from 50 per cent. to 60 per cent. of the light falling upon it. This furnishes the best possible conditions for placing light units well up from the floor. There is no necessity, for example, in hanging arc lamps far below the ceiling. Where show cases, or shelving with glass doors are used on the walls, particular care must be taken to place the light units high enough so that they are not reflected in the glass.

DECORATIVE FEATURES.

The advantage, if not absolute necessity, of making a store a thoroughly attractive place in every way, rather than a mere storeroom for merchandise, is one of the distinguishing features of the modern idea of trade. This idea has been developed largely within the past decade. It is not long ago that the aggressively ugly open arc lamp was in common use in many of the larger and finer stores through-

out the country. When fitted with the proper globe, and equipped with the best of carbons, the illumination, in point of mere quantity and color quality, cannot be surpassed at the present time; but from the decorative standpoint it was simply impossible. The enclosed arc has been developed into a form far less ugly, and even susceptible of decorative treatment, and in the best installations at the present time, in which ornamental cases and globes are used, and the lamp is suspended by a chain, the appearance is at least unobjectionable.

The manufacturers of the so-called gas arcs have missed an opportunity in this regard. These lamps are readily susceptible of highly decorative treatment, which would add very materially to their desirability for store illumination. When incandescent electric lamps are used the same opportunities for decorative light are offered in store lighting as in other cases, and many fine installations may be found in use. In seeking for legitimate decorative effects, however, particular care must be taken that the desired illumination is not reduced nor distorted. Store illumination is first and foremost utilitarian. No amount of decorative effect of fixtures can atone for bad illumination of the goods to be sold. This is an additional reason why store lighting installations should be passed upon by a competent illuminating engineer.

Interior view of one of the largest music houses in the country. An attempt was made to use decorative fixtures, but from lack of engineering knowledge, the resulting illumination was so poor that the globes evidently had to be removed, leaving the unfinished fixtures in place with their bare lamps. The illumination is still insufficient to show the dark cases of the instruments, and has a very unfinished and make-shift appearance.

SPECIAL LIGHTING.

In store lighting general illumination of the intensities previously mentioned must be provided; but there are many cases in which special lighting for special effects must, or should be, installed. Show cases furnish an important example. On account of the reflection from the glass it not infrequently happens, especially where numerous small units are used, that their reflections more or less completely obscure the view of the goods displayed. A case of this kind is shown in Fig. 1. This is a store handling jewelry, silverware, and objects of art, and the illumination is by electric lamps studded on the ceiling, as shown. The general effect is very similar to that of the "Penny Arcades." As a spectacle, the lighting is very attractive, but as a means of showing the goods, it is glaringly defective. The photograph shows the goods in the cases to a greater extent than they appear to the eye of a customer. The reflections of the numerous light-sources in the glass of both the side and counter cases distract the attention and hide the goods to a large extent.

The lighting of a show case is very similar to the lighting of a show window, and the one satisfactory method is by means of concealed lamps within the case. Lamps of tubular form are now to be had in this country, which lend themselves admirably to this purpose by reason of the very small space which they can be made to occupy. For counter cases, portable lamps at suitable intervals furnish an excellent illumination, and add immensely to the decorative appearance of the store. Wall cases, as indicated, should be lighted by lamps in reflectors placed along the upper front corner.

The example shown in Fig. 1 affords ideal opportunities for indirect lighting, since the ceiling consists of a number of flattened domes, each of which would serve as a large diffusing reflector, while the fixture itself could be made as artistic as fancy or expense might dictate by the use of art glass or crystal decorations. With a general illumination thus produced, of not too high intensity, and the wall cases brilliantly lighted from within so that the goods would stand out distinctly from the general illumination, and a collection of portables on top of the counter cases—which would have afforded an opportunity of showing the portables, which are one of the lines handled by the store, an exceedingly artistic general effect would have been produced, which at the same time would bring out the goods as the most prominent feature.

In some of the most modern stores in the large cities, special rooms have been fitted up, equipped with both gas and incandescent electric lamps, for the purpose of showing how colored fabrics will appear under the ordinary conditions of artificial light. These are intended for use during the daytime, as well as the evening, and are especially for the purpose of displaying millinery and dress goods. These are the most common of the cases of special lighting, and others which occur must be solved by the ingenuity and study of the particular conditions involved, by the illuminating engineer.

COST OF INSTALLATION.

The first cost of a lighting installation is very apt to be given undue consideration, whether in a store or other building. As compared with the cost of the building itself, or even with the other utilities provided, the lighting installation is very frequently skimped beyond all reason. The interest and depreciation of the lighting

installation is an insignificant item in comparison with the importance of good illumination; and, for the sake of some small economies in the first cost, to entail a perpetual loss in results is manifestly a very short-sighted policy. Practically the only question to be considered, therefore, is the results obtained and the cost of operation and maintenance. The only debatable question is that of the purely decorative features, and this must be considered with a view to the actual pecuniary advantages which an attractive store offers; in fact, the cost of the purely decorative features might very properly be charged to the general advertising account, as would an electric sign.

COST OF OPERATION.

By this is to be understood simply the cost of supplying the luminant. While this will vary under local conditions, it is a well-known fact that mantle gas burners still afford the cheapest method of producing a given quantity of light, with the electric arc a close second under many conditions. The conditions are so varied that each particular case must be decided on its merits.

COST OF MAINTENANCE.

By this is to be understood all expense connected with repairs, renewals, cleaning, and general attendance of the lighting units. The importance of this item varies from one of comparatively little importance in the case of very small installations, to a matter involving many thousands of dollars annually in the large department stores. The maintenance expense may be properly divided into three heads:

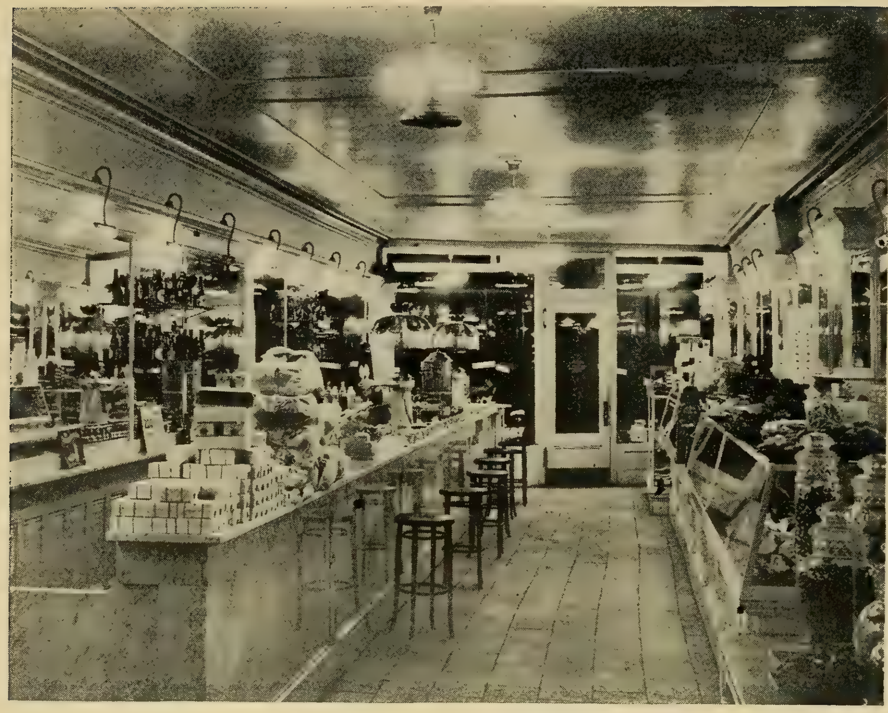
First—For regular renewals.
Second—Labor.
Third—Repairs.

In the first division is included globes and carbons in the case of arc lamps; new lamps in the case of incandescent electric lamps, glowers, heaters, globes, etc., in the case of the Nernst lamps; and mantles and chimneys in the case of incandescent gas lighting. With reasonable care the costs should fall within the following limits, the amounts being figured for 1,000 spherical candle-power hours:

Arc lamps (enclosed)	½ to 1c.
Carbon filament electric lamps..	3 to 6c.
Meallic filament electric lamps..	4 to 20c.
Nernst lamps	½ to 1c.
Incandescent gas lamps	2 to 5c.

The cost of labor is a much more indeterminate quantity, depending upon local conditions, as to wages, necessity of employing special laborers for the purpose, the degree of skill required, etc.

Under repairs are to be included cleaning, inspection, and general oversight. Only one general fact need be laid down in this respect, and this is the necessity of keeping the lighting installation in first-class order, for reasons of both economy and satisfactory results. There is no other utility in modern use which is so generally neglected as the lighting installation. The waste occuring from this is beyond all reason. Merchants who have their windows washed daily leave the incandescent lamps, with their globes or shades, untouched for a year at a time, while gas burners are allowed to run as long as there is a fragment of the mantle in sight. Regular and systematic inspection and cleaning of all parts accessible, and the immediate renewal and repair of worn or defective parts is an absolute requisite to satisfactory results from any installation, and any other treatment must be set down as unwarranted carelessness.



A Novel Installation for Store Lighting

The above illustration shows the interior of a confectionery store on Broadway, New York. The illumination is entirely by O'Brien lamps. This lamp is a carbon filament electric lamp in the form of a tube about one inch in diameter, and 10 inches long, in which the filament is placed in a straight line in the center of the tube. The fixtures at the side hold single lamps, while those suspended from the ceiling are made up of four lamps joined in the form of a hollow square. The lamps in this case are used without reflectors, as the ceilings and side walls are white. The cut is from an untouched photograph taken wholly by the light of the lamps, and is surprisingly free from halation which is the photographic equivalent of glare.

As a whole, the illumination is exceedingly attractive, owing to some extent no doubt to its novelty, and yet there can be no question as to the uniformity of distribution and general brilliancy. While illuminating engineers would probably at once criticize the exposing of the naked filament to the eye, the effect of glare for some reason seems to be far less objectionable than in the case of lamps having the filament coiled into the familiar loop. This is the first installation of these lamps for general illumination in this city, and is certainly a success at least in point of general attractiveness.

Daylight Illumination of Stores

By O. H. Basquin.

With the exception of direct sunshine one hardly ever obtains too much daylight illumination for the efficient sale of goods. With respect to the other limit, namely, the least illumination which can be used to satisfaction, a great diversity exists among different classes of goods as well as in the preference of different salesmen in the same kind of merchandise.

No very definite rule can be given for the illumination required. In general the illumination must be greater for goods of fine texture, for those of dark color and for those in which the quality depends largely upon color and shape. For the examination of silk goods one needs a much stronger light than for that of horse-blankets, the colors are likely to be darker, the texture itself is finer and more particular attention is given to the study of color in the one than in the other. Goods which sell at high prices are generally given the preference with regard to illumination. Their quality should be such as to sustain closer scrutiny and the purchasers of such goods should be made as comfortable as possible at the time of the sale. For the sale of tinware and for the larger articles of hardware a rather small illumination can be tolerated in the second case because of the coarseness of the goods, and in the first because of their bright surfaces.

A salesroom which is entered directly from the brightly illuminated street should have a better illumination than one which is entered through another salesroom The reason for this has to do with the physiology of the patron's eye. When he is out doors where the illumination is great the pupil of his eye is contracted; as he enters the salesroom his pupil is still small, but slowly increasing in size as its owner attempts to look about. If one notices too great a change in illumination on going into a store an impression of gloom is given to the customer at the very time when he should be impressed with the cheerfulness and the general attractiveness of the salesroom. In going from one room to another in a large store this effect is practically lost so that the illumination may be reduced as one goes farther from the entrance.

In determining upon the arrangement of a salesroom with respect to lighting fixtures, one tries to provide that illumination which accords best with the taste of the sales people, with the needs of their customers and with the financial resources available for purposes of illumination. The man who makes this selection will do well to visit all the shops within reach where the same class of merchandise is sold, and in making this examination he must look at each shop from the standpoint of the prospective purchaser of goods. After critically comparing the illumination of a few shops in this way he will be better able to make a judicious selection of window fittings and to arrange his store fixtures to good advantage.

Very much depends upon the arrangement of the store fixtures within the salesroom. The room most easily lighted is one with a high ceiling, with perfectly plain walls unbroken by offsets of any kind, with whitewashed walls and ceiling, and, finally, a room devoid of furniture. Such a room

would be of little practical value unless it were for a board of trade or for some other purpose requiring no furniture. Such a room may, however, serve a useful purpose as the ideal toward which the actual room should be made to approximate as nearly as circumstances will admit. The average American store has a high ceiling, is long and narrow and derives the most of its light from the window facing the street. The customary arrangement of the shelves for the storage of goods along the side walls, and extending sometimes up to the ceiling, is as good as one can desire. If the goods can be kept in drawers or boxes—as is the case in shoe stores—and if these drawers or boxes have white ends, the ideal condition is closely approximated.

The forming of alcoves by placing some of the cases transversely across the floor should, of course, be avoided. The counters should run parallel to the side walls and if the store is so wide as to need another set of counters running down the middle, the shelving for the storage of goods between these central counters should be kept as low as possible. All dark colored furniture should be avoided, from the standpoint of illumination, and in the arrangement of fixtures the general attempt should be made to allow free access of the light from the windows to every part of the store where light is wanted. In this connection one must not neglect the diffused light from walls and ceiling, this is what makes ordinary daylight illumination so much more satisfactory than that due to artificial light, and it is for the lack of this diffused light that it is so hard to get a good illumination through a small opening in a wall or partition.

Most shop keepers are much impressed with the importance of the show-window as an advertising agent and are very loth to make any change in their windows for fear of decreasing the efficiency of their display. While there is no doubt that the display is of great importance, it is also true that in most of the stores of America the daylight must all come in through the front window, and unless one is permitted to discuss certain modifications in this window which affect the distribution of light his resources are very much limited.

Fortunately, stores in this country are built with high ceilings so that, in most cases, there is room both for adequate display and for the admission of light. The show-window is designed to attract the attention of people walking along the sidewalk. But, in order to walk without stumbling, one must have his eyes cast somewhat downward toward the street surface, and people have become so accustomed to this position of the eyes that they generally walk with eyes lowered even when the sidewalk is entirely smooth. These considerations suggest that a man's attention is hardly likely to be attracted by goods displayed more than eight or ten feet above the level of the walk. We shall assume, then, that the upper four or five feet of the show-window is of little value for display purposes and may be counted upon as the main avenue through which the daylight may be led into the salesroom.

From this point of view the desirable show-window will be something like that shown in Fig. 1. This figure represents a vertical section through the sidewalk, window and end of salesroom. The floor of the show-window is raised, as is usual from eighteen inches to two feet, and the window is completely inclosed to protect the goods from rust, moisture, etc. The back and top of the show-window

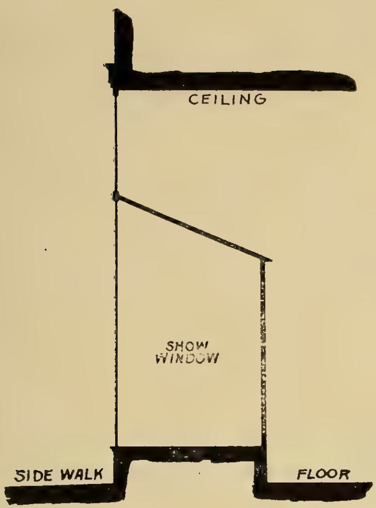


FIG. 1.

might be made of glass, but the display generally shows up better with an opaque background specially adapted to it. The top of this show-window is generally made of rather dark wood, but a little consideration will show that it may be given a rather light color to good advantage.

Let us assume that the buildings on the opposite side of the street from the window under consideration have a height equal to two-thirds the width of the street, and let us further assume that the upper part of the window—the transom—shown in Fig. 1, is filled with ordinary plate glass. Then the distribution of the daylight coming through the window is something like that shown in Fig. 2, where the lines in different directions represent rays of light and with one exception, all rays represent the same amount of flux. The line at ten degrees from the vertical is drawn as dashes because it represents only half as much light as the others. These rays from the sky go straight through the glass and nearly all of them fall upon the top of the showcase. The rays which escape the top of the showcase fall to the floor at a short distance back from the window.

If the buildings opposite the window were lower, and if the show-window top were steeper, more rays would evidently get past and fall to the floor, but the assumed conditions are fairly representative for middle sized towns. We see that most of the light is lost on the top of the show-window. If this top were painted white it would help matters very much. If it is painted a light yellow it will give a warm tinge to the whole interior. But this is not a very efficient way to get the light back into the room, though it may answer the purpose for stores that are very shallow. The reason for the inefficiency is that the paint forms a diffusing surface which, instead of throwing light straight back, throws it off in all directions according to the cosine law. The most of this light then goes to the ceiling before it finds its way to the working part of the room, and no small part of it is thrown outdoors again.

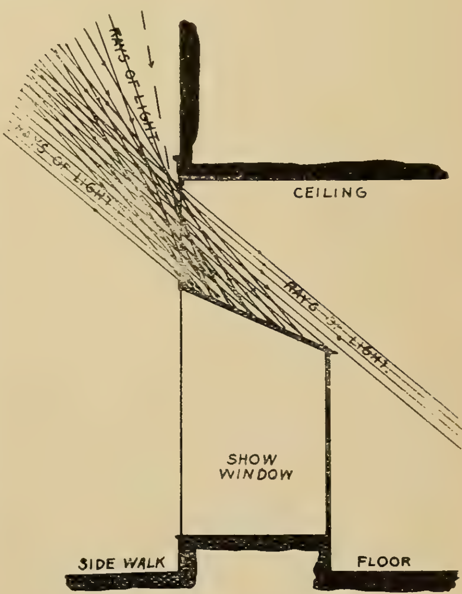


FIG. 2.

It is evident that a large mirror might be placed on the top of this show-window to considerable advantage. Oddly enough, the writer is not aware that this mirror suggestion has ever been tried. Cheap mirrors when used in a similar way for the reflection of light present to the eye a rather unpleasant appearance, and in this case the mirror is so low that its light would be particularly unpleasant in the eyes of one looking toward the window from the interior of the room. Notwithstanding these objections it is quite likely that this device would prove fairly satisfactory in many cases.

Frequently one finds a window built similar to the one shown in Fig. 3. The owner has realized the uselessness of the upper part of his window for purposes of exhibit and hence thoughtlessly has cut it off with a horizontal top. It will be admitted that this form of top is more in harmony with conventional principles of design; mankind has seen so many surfaces meeting at a right angle that we generally prefer to see that angle used unless there is good reason for departing from it. This window top

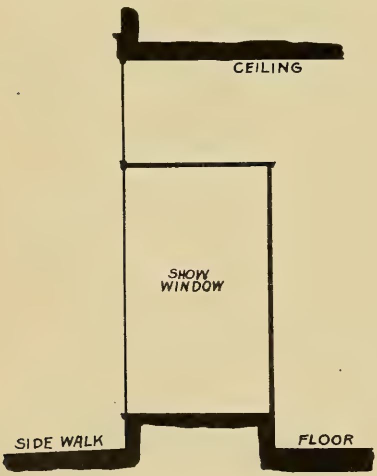


FIG. 3.

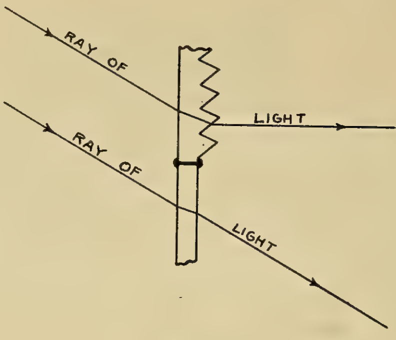


FIG. 4.

very greatly interferes with the daylight illumination of the room. It not only receives all the direct light itself but it is so placed that none of the light which it throws off can reach the working part of the salesroom without first going to the ceiling. Furthermore, none of the devices which are still to be mentioned, as likely to give greater efficiency, will work well with this horizontal top. It is to be hoped that the public will sometime become so familiar with a few of these elementary principles of daylight illumination that these blunders will be less frequent and will be seen and appreciated by the ordinary individual.

Window-prisms have been on the market and have been largely used for eleven years. They consist of pieces or sheets of perfectly clear glass placed in the window sash in place of the plate glass. On the outer face these sheets or plates are flat, but the inner face is broken up into horizontal ridges with flat faces. These ridges form the prisms, from which the device receives its name and upon which, in a very simple way, its somewhat surprising properties depend. The upper part of Fig. 4 represents a section of a part of a prism plate, while the lower part shows a piece of plain glass. The path of a ray of light is

shown through each piece of glass. Both rays are initially parallel; as each enters the glass its path is somewhat changed in direction according to the law of refraction. The two rays still remain parallel, the one in the prism and the other in the plain glass. As the rays emerge from their respective pieces we see that they take entirely different directions. Since the second face of the plain glass is parallel to the first one, the law of refraction brings the final direction of the lower ray parallel to its initial direction. The inner face of the prism, however, makes a large angle with the outer face and, on leaving it, the ray of light, in obedience to the same law of refraction, is bent upward instead of downward. Rays from other directions are all bent more or less upward in a similar fashion and the net result is that the daylight which comes through such a prism plate is sent farther back into the room than that coming from plain glass.

Let us go back now to Fig. 2 and consider the effect of placing window prisms in the transom in place of the clear glass formerly assumed there. The light coming from these prisms, if properly selected, will pass directly back into the lower part of the salesroom. The counter with the goods displayed on it, though it may be half way back in the store, will receive direct light from the window. This direct light comes without loss due otherwise to diffusion. In addition to this direct light, the counter back in the store receives diffused light from sidewalks, and this, also, is stronger than in the case of plain glass because of the stronger direct light falling on the walls.

It should be clear that prisms do not manufacture light in any way; they do not increase the light, they alter its distribution. They reduce the excessive and useless illumination on the top of the show-window and increase the illumination on the sales counters.

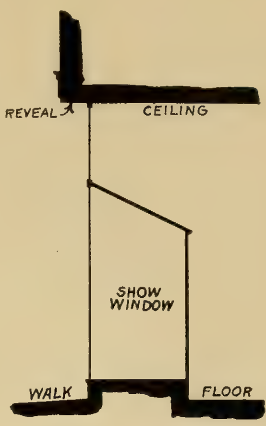


FIG. 5.

The inner faces of prisms must be variously inclined to suit the locality in which the prisms are used. If the opposite buildings are low the prisms are less inclined and vice versa. In selecting the prisms for any window one must know the directions from which the light comes to the window, also the directions from the window in which it is desired. This information is generally best given by means of a vertical section through the room, the window and the opposite building.

In a great many of the older buildings the windows are set back from the face of the building to give the wall an appearance of strength. This distance by which the window is set back, or rather, the distance by which the window-cap projects over the window, is called the reveal. So long a the window is of plain glass it is a matter of indifference whether the glass be flush with the face of the wall or set back several inches, but with window prisms it is quite a different matter. If they are set behind a heavy reveal the ledge casts a deep shadow over them. They cannot transmit light which they do not receive; the

sheets of window-prisms should always be placed flush with the face of the wall. If the window cannot be moved out conveniently, the prisms may be set in a separate vertical frame outside the plain glass window.

The door forming the entrance into the store may well be placed flush with the show-window. In this case it will naturally extend to the transom bar above which the prisms will be located. In most stores the owner desires to have the door set back even with the rear of the show-window; in this case the prisms should continue over the doorway in the same plane as those over the show-window. Of course, it will not do to bring them in and put them over the door in its usual position.

The canvas awning, which is used in summer to protect the show-window and its admirers from the sunshine, should run from the transom-bar below the prism plate and not from the extreme window top, as is frequently seen. In this case the transom bar will appear a little heavier than that shown on the sketches, and the awning may be made more nearly horizontal than usual by giving the support rods a sliding hinge instead of a fixed one.

When the sun shines on the prisms it is generally not necessary to diminish the light thrown into the room. On bright days in summer, however, and particularly with a south or west exposure, this sunshine through the prisms is likely to be uncomfortably strong and, for such occasions, white Holland shades should be provided, which pull down just inside the prism sheets. They are, of course, easily and quickly adjusted from the interior to suit the convenience of the salespeople. This white glazed material is a most excellent one to serve as a sunshade on any window independent of the presence of prisms. In the sunshine such a shade gives off a strong, well-diffused white light highly agreeable to the eyes. This light resembles sky-light very closely.

The prisms accomplish their purpose by directly throwing the skylight back into the store. If one stands back by the counter and looks at the prisms he sees the sky through the prisms. If the prisms throw a good light in his direction they must necessarily look bright to him. This is the simplest manner of testing whether the prisms contribute properly to the illumination of any locality; place the eye there and see if the prisms look bright. This very feature of their use sometimes makes the prisms rather annoying in a salesroom which is unwisely decorated. As the customer walks into the store and down the aisle the bright light from the prisms is on his back and in the face of the salesman who comes to meet him. The face of the prospective buyer is lighted by the diffused light from walls and ceiling and, if these surfaces are not pretty light, his face is hard to recognize, so long as he keeps his back to the window. The moral of this is to make the decorations as light as possible. In any event the salesman may be sure that this inconvenience is little detriment to trade, for under the circumstances described the customer is perfectly at his ease and the whole interior looks bright and cheerful to him.

With increased height of the buildings opposite a window, less skylight falls upon the prism plate, and the prisms appropriate to such surroundings appear less and less bright from the interior. When the opposite buildings become much taller than the width of the street, it generally becomes advisable to set the prism plates in a frame inclined to the vertical, a-

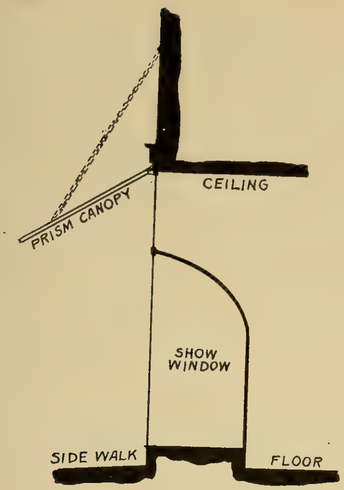


FIG. 6.

position in which a much stronger light falls upon the prisms. This construction is illustrated in Fig. 6, which represents a vertical section similar to the other figures shown. The prism sheet in this position has been called a *canopy* and serves to protect the window and the passer-by from wind and rain. Even on a fair day many a shopper will stop and look at such a window simply because of the impression of shelter and protection afforded by the canopy.

The upper surface of such a canopy is smooth and should be cleaned frequently. A cleaning once a week will give excellent satisfaction in most localities, while it is safe to say that in most places these canopies are cleaned much less frequently—a few times a year, perhaps. The prisms themselves are of clear glass, but they are deeper and sharper than window prisms. The faces are arranged so that they act by reflection instead of refraction, but they are not silvered. It is the sort of reflection which one finds when he tries to look diagonally through the bottom of a glass full of water. One finds that for certain angles he cannot see through the bottom, it becomes a perfect reflector. The canopy gives a good light under almost all circumstances.

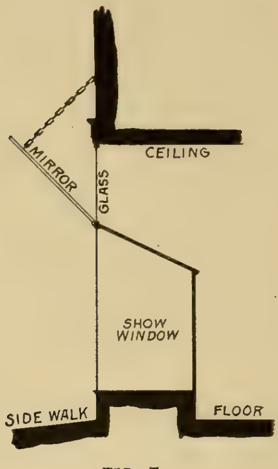


FIG. 7.

In England the old-fashioned mirror reflector shown in Fig. 7 has been used a great deal, and to some extent, also, on the continent of Europe. It is made of a thin glass having shallow flutes about an inch wide. The lower side is silvered. The glass is mounted in a wooden frame and has a wooden back or lower side. These mirrors give a good light—hardly as good as that of the canopy, however, but they receive from the sky a much smaller amount of light than the canopy does. On the other hand, they present a rather disagreeable appearance from the interior and their sloping position on the window, as seen from the street, does not agree well with ordinary architectural lines. As generally used they are much smaller than they could be to good advantage; the top of the mirror may run well above the top of the window. Their mounting should admit of lowering for frequent cleaning.

In remodeling an old store it is quite common for the front on the ground floor to be set out several feet

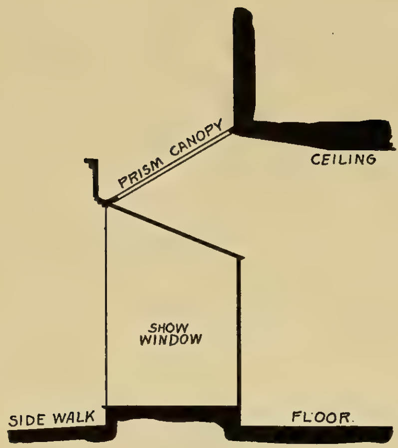


FIG. 8.

beyond the face of the building. This alteration furnishes opportunities for obtaining an excellently lighted sales-room by working in a canopy prism plate over the show window as shown in Fig. 8. The illustration shown in Fig. 9 is from a photograph of a large new store in Hanover, Germany, where the show windows have been treated in a manner similar to this. Fig. 10 shows a similar suggestion in which the mirror is used in place of the prism canopy. This detail gives opportunity for a high show-window. The purpose of the clear glass above the mirror is simply to keep out the weather. If this glass were removed and placed in a vertical position behind the show-window, it would improve the appearance from the interior, but would involve difficulties in a snow storm.

On the continent of Europe the property owners are not allowed to excavate and make use of the space below the sidewalk and beyond the lot line.

FIG. 9.

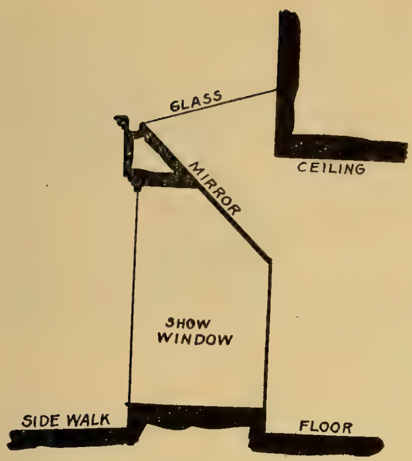


FIG. 10.

The show-window is sometimes arranged as shown in Figure 11. The window is carried down several feet below the level of the sidewalk with a narrow area in front. A delicate railing prevents the public from coming too close. The lower part of this show-window has at least one advantage over the upper part. In bright sunshine one finds it almost impossible to see clearly the objects in the ordinary show-window. The reason is that the street surface under the direct sunshine is so bright that its reflection from the face of the glass is stronger than the direct rays from the feebly lighted display in the window. About the only way to obviate this difficulty is to raise the awning and let the sun shine in the window, but this will drive the public to the other side of the street. Now, in looking at goods in the lower part of the window shown, one gets from the face of the glass the reflection, not of the street surface but of the vertical area-wall or curbing just below the observer. By making this surface fairly dark its reflection is not seen and the objects in the lower show-window come out distinctly.

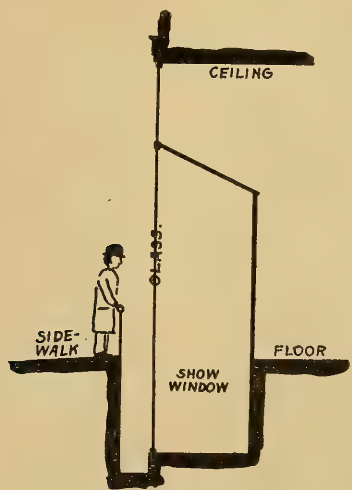


FIG. 11.

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Decorative Effect in Store Lighting

No argument is needed to establish the truth of the proposition that attractiveness is one of the chief elements of success in the store of today. The term "attractiveness" includes a wide range of general principles and details. It applies to the appearance, as well as the personal qualities, of the salesmen or saleswomen; to the arrangement and display of goods, as well as their inherent qualities; to the structure and decoration of the building externally and internally; and to the general effect of the *tout ensemble*. Magnificence is by no means an essential to attractiveness. The smallest store, handling a single specialty, can have all the elements that invite the purchaser to quite as great an extent as the most gigantic merchandise palace; in fact, there is an element exclusiveness and homelikeness possible in the former that is practically impossible to attain in the latter.

In the old days, when A. T. Stewart was the merchant-prince of the country, the saying was common in New York that "after all, Stewart could not sell all the dry goods that were needed in New York;" and neither did he, nor will any of his successors, no matter upon what magnificent proportions they may conduct their establishments. The importance of lighting as an element in the success of the merchant is more particularly dwelt upon elsewhere in this issue; we wish here simply to make the fact more impressive, that the artistic element in store lighting is far from being a mere whim, an unremunerative embellishment, but is essentially a financial proposition. "Old Gorgon Graham" reminded his son that "while clothes might not make the man, they make all you can see of him except his face and hands, during business hours," and gave some of his common sense advice in regard to giving proper attention to personal appearance. So the show-windows and the lighting fixtures in a store do not make the merchandise; but it is a logical inference, and therefore one which the mind will instinctively make, that the store which is dressed tastefully, and richly but not gaudily, will carry the same good judgment and good taste throughout its entire management.

This attractive fitting of the store, of which the lighting forms the most important part, is particularly important in that class of stores which deal almost entirely with transient trade, of which drug and confectionery stores are the most important examples. We illustrate on the front cover of this issue a particularly attractive lighting installation of this class. The view shows the interior of one of the "Mirror" candy stores in New York City. The fixtures are largely of crystal glass, and the mirrors so placed as to reflect the fixtures without interfering with the display of the goods. The use of mirrors and attractive lighting fixtures is the distinguishing feature, as the name indicates, of this house, and the justification for their faith in this means of attracting custom is found in the rapid multiplication of their stores.

The Relation of Architectural Principles to Illuminating Engineering Practice

One of the most important papers thus far presented to the Illuminating Engineering Society was read by Mr. Bassett Jones, Jr., before the New York section, having the above title. The importance of the paper arises not only from the serious and comprehensive manner in which the subject was handled, but also as an evidence that the claims of the illuminating engineer are beginning to be recognized by the architectural profession. The text of the paper shows that Mr. Jones is an exceedingly close and conscientious student, and possessed of the requisite artistic temperament to thoroughly appreciate the spirit as well as the letter of the science of esthetics. Mr. Jones states that the chief purpose of his paper "is to show that the illuminating engineer who considers only the scientifically practical side of the profession, is necessarily doomed to ultimate failure, for he will not be able to obtain the recognition that the importance of his work deserves." Of the truth of this proposition there can be no doubt, and Mr. Jones' note of warning is timely.

After thus setting forth his purpose, Mr. Jones proceeds to give a brief review of the fundamental principles of esthetics, and afterward to apply these principles to concrete examples, and general cases. As a summing up of the principles of esthetics Mr. Jones very aptly says:

"The mind instinctively asks, What is the thing for? and unless the answer is forthcoming, no amount of grace or ornament can overcome the ensuing feeling of repulsion. We find ourselves in a strange place, and the ruling impulse is to escape."

In other words, every structure or accessory thereto must be able to give a satisfactory reason for its existence. As in society, those elements which have no visible means of support, or cannot explain their presence in unlooked for places, are outlaws. This single dictum, applied in the right spirit, would be a wholly sufficient guide for illuminating engineers, and other artisans, in the matter of esthetics. But imagine for a moment this rule literally applied to present day lighting fixtures; the collection of metal work which could give no satisfactory account of itself would rival the salvage from the San Francisco earthquake.

Emerson boldly proclaims his fearlessness of consistency, and Mr. Jones is apparently a disciple of Emerson in this regard—which is by no means a reflection upon his depth of thought and earnestness of purpose—for in his critical discussions he several times

commends features which are contrary to the dictum above set forth. Thus he says, "A lighting fixture must be proportionately heavy if it is to be employed in a room of massive construction." Suppose we apply the test by asking, What is the thing for? There is but one possible answer—to support a number of lamps, that is, apparatus for generating light, with whatever accessories may be used for modifying the rays. The design and construction of the fixture furnish the material answer to this question; and in the case of some of the huge and unwieldly contrivances which we have noted on previous occasions, the answer will certainly be most ludicrous. Mr. Jones' argument is, that without this massiveness the "feeling of balance will be disturbed." The theory of proportion must, of course, be observed in esthetics, but in this case the balance is not between the fixture and the building, but between the fixture and its legitimate and unequivocal purpose of supporting light-sources. The principle laid down, if rigidly enforced, would eliminate all the imitations which are so grossly apparent in most attempts at decorative designs at the present time, and which Mr. Jones seems to approve of, such as the familiar opal glass "candle," the Roman lamp, and the torch.

The fixtures in the lobby of a prominent New York hotel were cited as an example of good design. The fixtures referred to are chandeliers of massive construction, which presumably are intended to represent the primitive device of a large bowl of oil, having individual wicks about its circumference, these wicks being represented by six 32 candle power electric lamps, with art glass shades, probably intended to imitate flames, and a preposterous column in the middle of the bowl supporting a 50 candle power lamp. Incidentally this bowl shuts off a large part of the light from below, where it is most needed. The absorption of the shades and the shadowing of light are so excessive, that the resulting illumination is far below that required to read ordinary newspaper print with any comfort. There are five of these fixtures beside a standard supporting four lamps, in a narrow hallway about seventy-five feet long, finished with walls and ceiling of light tint and still the illumination is decidedly gloomy. We might fancy the test question being put to this fixture, and its blusing and faltering reply, "I am an old Roman lamp." What would be the involuntary answer to this reply? In terse American—"You are a liar, and a poor sort of one at that, for your lie is so evident that it would not deceive a child. Away with you!"

"Beauty is truth; and truth, beauty," is one of the apt quotations in Mr. Jones' paper. All untruths, deceptions, imitations, theatricalities, are the very antithesis of art, and to the extent that they are used is art prostituted. A careful distinction, however, must be made between imitation and simulation. Imitation is a deliberate attempt to deceive, as when a porcelain tube is set up like a candle in a support in the form of a candlestick. Simulation embodies a resemblance, but appeals to the imagination to complete the image. A lamp shade having the general form of a flower is an example; the mind does not for an instant mistake the similarity for actual fact, but is led to the conception, possible at least in the imagination, of a flower that gives light. It is in such symbolism that art finds one of its highest modes of expression.

"The Illuminating Engineer," observes Mr. Bassett, "who imagines that he will be permitted to introduce

anything radically new into the illumination of buildings possessing historic feeling is doomed to disappointment; rather it is his duty to maintain and conserve that feeling in spite of modern appliances and means." While this expression contains an element of truth, if taken literally, it would be a wholly unwarranted stumbling block in the path of artistic progress. It is said that after the first settlement of the Pilgrims in this country, the question of their title to the land as against that of the native Indian, gave some trouble to their Puritan conscience, until it was allayed in a most satisfactory manner by the promulgation of two resolutions: First, that the land belonged to God's people; second, that the settlers were God's people. And so, as it is practically impossible to construct a building without making some use of historical precedence, it would only need the declaration that the building had "historic feeling" to exclude all improvements in illumination. Art never has prospered when working in fear and awe of historic feeling, and the artistic sins that are committed in the name of history are beyond compute. As a simple truth, every historic period that has produced vital and living types of architecture made use to the fullest extent of the sum of human knowledge at the time; every resource was used to its utmost, and if architects imagine that progress in art, as well as in science, is to be tied to the apron strings of Dame History, they are grievously in error.

Time is only waiting for the advent of a creative genius who will handle the wonders of modern science as did the masters of old the colors on their palates, and fearless alike of decrepit custom and future criticism, will produce such original creations as will suit an entirely new limit to the flight of artistic imagination.

The Sale of Illumination

A recent issue of the *Journal of Gas Lighting* (London), discusses somewhat at length the question of selling illumination, referring particularly to a paper upon this subject read before the last annual convention of the Empire State Gas and Electric Association, to which Mr. Leon Gaster called attention in his recent paper on "Illuminating Engineering," before the Society of Engineers-in-Charge (London). While not strongly dissenting from the views which were expressed in the paper referred to, and also put forward from time to time by the writer editorially, the *Journal* seems a little aggrieved that we did not make out a stronger case against electric lighting. The question of whether gas or electric lighting stands most in need of this reform, seems to us foreign to the issue. The real problem is, whether the public would be better served by basing their payments for public lighting upon the illumination produced, measured by the best means at hand, than under the present system of paying for the illuminant, whether gas or electricity. The matter resolves itself simply into the question of whether the means at hand for measuring illumination, i. e., the effect of light in rendering objects visible, are sufficiently accurate to afford a practical basis for money valuations. We have stated on several occasions our belief that such is the case; but since our last comments on the subject, two new illuminometers have come to our attention which are apparently improvements over those previously in the field; one of these in particular, upon somewhat superficial examination, seems to overcome the most serious faults in previous instruments so that, as stated in the paper referred to, we believe the science of illuminometry has arrived at

a degree of precision which would justify its utilization, in a conservative manner, as a basis of valuations in the sale of light.

The *Journal* takes exception to our statement that "in the case of gas lighting, it is the gas and not the light that is sold," putting forth the argument that "gas has to possess a definite minimum candle power prescribed by the legislature, and this is tested, or in other words, measured, quite as much as the quantity of the commodity sold." The consumer, therefore, actually buys light, and happily for him he is enabled by the incandescent gas system to get much better value for his money than the law ever contemplated. It is absurd to suggest that he simply purchases an illuminant without any reference whatever to illumination.

This argument seems a complete confirmation of our contention. The individual or municipality which buys 1,000 feet of gas may burn it in an antiquated flat flame burner, or in the most improved mantle burner, maintained in perfect condition, which would give from five to eight times the amount of light; and the light thus produced might be left to its own free course and only a quarter of it used to illuminate the desired objects, that is, produce illumination; or it might be distributed by the most improved apparatus producing four or five times the amount of illumination per spherical candle. The difference between the worst and best methods is, therefore, extremely wide. With the individual the responsibility is readily placed, and if he wastes his illuminant he has only himself to blame. But in the case of public lighting, the waste of illuminant means more illuminant sold, and, therefore, puts a premium upon bad practice. We are ready to admit that this argument has far less force in some European countries (we cannot speak from personal observation as to England) than in this country but it is assuredly good political economy to draw public contracts, if possible, in such a manner as to put a premium upon efficiency and good practice. If the compensation to the gas or electric company were based upon a measurement of actual illumination, it would be for the interest of the companies to produce this illumination with the least outlay for illuminant and apparatus. Any improvements in efficiency would, therefore, at first benefit the customers, which would be only a just compensation for the original outlay involved in developing the improvements. Ultimately, following the general law of supply and demand, the public would share in the benefits.

Referring to our illustration that "a coal bill is never spoken of as a heat or power bill," the *Journal* characterizes it as "an odd remark; for if light is to be sold in foot-candles, why should not the author advocate the sale of fuel as applied heat units? One can imagine the plight of a coal merchant who has to charge according to the amount of physical heat which some fireside student manages to absorb into his system during the course of a winter's evening." The writer again seems to have unwittingly furnished us with a new argument. The student might very justly maintain that he was not at all concerned with the price of coal, that the only condition which affected him was the temperature of his room, and might with perfect reason stipulate in his lease that the temperature of his room should never fall below a certain minimum, and leave it to the lessee to generate the necessary heat by any means he saw fit. So the public, in dealing with its lighting, is not bound

to concern itself with just what means are used to produce light from the illuminant; its only demand is that the illumination of the streets and public places shall be of such a character as to enable them to be used with a certain degree of facility. The only difference in the two propositions is the difference between the simplicity and accuracy of a thermometer, and the best present form of illuminometer.

Effects of Light Upon the Eye

A brief but valuable paper on this subject was presented before the New York Section of the Illuminating Engineering Society at its regular meeting on the 9th, by Dr. H. H. Seabrook. The following is among the important conclusions reached by Dr. Seabrook:

"You are asked to believe, what many of you already know, that the desire for intensity of light has been already overdone as regards the good of the eyes. The small but increasing portion of the consumers who wish a light that is soft to the eyes ought to be encouraged."

The cry for more light, which is a very natural slogan for the producers of illuminants and lighting apparatus, must be taken as a general rather than a special demand. There are undoubtedly many instances at the present time when a reduction in intensity of light would be a positive improvement, and it is in just such cases as this that the value of the independent illuminating engineer is felt. That there is ample room for more light there can be not the slightest doubt, but this light should be used to illuminate the dark places rather than to increase lighting that is already sufficient or excessive. To foist on to a customer all the light that he will "stand for" is a short-sighted commercial policy on the part of the interested party. There is plenty to do in hunting out dark places and seeing that they are lighted up.

Another important fact brought out by Dr. Seabrook's paper is the increasing necessity for protecting the eyes against the chemical or ultra-violet rays. Increased efficiency in the production of light thus far has resulted in a large increase in the amount of these injurious rays, and the globe or shade of the future must be more than a mere contrivance for reflecting or diffusing light; it must be a ray filterer, which will absorb the injurious radiations.

Illuminating Engineering in England

At the last meeting of the Association of Engineers-in-Charge (London) Mr. Leon Gaster read a paper entitled "The Province of Illuminating Engineering." The announcement of the forthcoming publication of *The Illuminating Engineer* in London had previously been made, and Mr. Gaster has for nearly two years been publicly presenting the claims of illuminating engineering, and endeavoring to arouse sufficient interest in the subject to form an association similar to The Illuminating Engineering Society of this country. Mr. Gaster's recent paper has attracted very general attention, and received wide comment in the electrical and gas journals of England.

From the reports of the discussion of his paper, it is evident that illuminating engineering as a distinct profession is far from meeting universal acceptance in England. The objections made have a very familiar sound to Americans who have been interested in the subject for the past ten years or more; they are the same old arguments which were made and exploded

here years ago. While there is general admission that lighting is by no means what it should be, the stock argument seems to be that the electrical engineer or contractor, or the gas company, should be able to handle this special department. "Self-preservation is the first law of nature," and it is the most natural thing in the world for the practitioners of any given profession to see very little use for any new profession which encroaches upon their preserves. For the same reason it cannot be expected that the technical journals will welcome too enthusiastically a new competitor for public patronage,—although in this special regard we must admit that the English journals have been extremely fair to the English *Illuminating Engineer;* in fact, Mr. W. H. Y. Weber, of the *Journal of Gas Lighting,* has contributed a special article to the first number. This is an act of broad-mindedness which is without a parallel on this side of the water.

The Gas World, however, shows a striking contrast to this progressive and intelligent spirit. Commenting editorially on Mr. Gaster's paper, it says:

> From the nature of the subject nothing very novel or striking was to be expected in such a paper; which nevertheless served a useful purpose in bringing the importance of the study of lighting effects under the notice of the Association. Whether there is enough in the science and practice of artificial lighting by gas or electricity to support a distinct branch of engineering is a question upon which professional opinion is, and will remain, divided. We refuse the invitation, whether offered by Mr. Gaster or anybody else, to hail the Illuminating Engineering Society of New York as the fount and origin of knowledge in this department of physics. If these Americans and their European admirers have only just awakened to the perception that there is, literally, more than meets the eye in the proper use of artificial sources of light, that is no reason why all the rest of the world should gape at their achievement. It is no news that American electricians knew very little about the laws of lighting when they first went into the business. Their "tower system" of town lighting, and their "French measurement" of arc lamps sufficiently demonstrate the fact. Gas engineers had their own views on the subject long before that; and the name of Sugg was renowned in this field of activity years before the first electric lighting "tower" was set up in the United States. It is not too much to claim that gas lighting never was, nor is now, done with such disregard of sound physical and physiological principles as commercial electric lighting is. It is the flame arc lamp that drives foot passengers away from shop fronts; and incandescent electric lamps which are so mixed up with the goods in shop windows that the dazzled eye can see little else. The success of the New York society appears to be largely due to the local circumstance of the gas and electricity supplies being in the same hands, which is not the case in England. We should think far more highly of the prospects of the new profession which Mr. Gaster aims to bring into existence if there were anything novel in the subject matter.

The sum and substance of this comment is, that "we know it all now, and have known it all for a long time,—ever since there was anything to know." For the person who realizes that he does not know all about a given subject there is much to hope, but the one who does not know that he does not know is a nearly hopeless proposition. If the sucess of the New York society is owing to the circumstances of the gas and electrical companies being quite generally combined in this country, it is an exceedingly strong argument for such combination. While the competition between gas and electrical companies has certain advantages, the persistent effort of each to belittle and decry the other is certainly not one of them. This very fact seems to us one of the strongest possible reasons for the establishment of independent illuminating engineering in Great Britain. There is much need there for the

lighting industries of all kinds to give less attention to plucking their beams out of their brothers' eyes and giving more attention to the motes in their own optics.

While the electrical journals have generally received Mr. Gaster's suggestion favorably, *Electrical Industries* falls back into practically the same position as that taken by the *Gas World,* namely, that there is really nothing in the subject, and, at any rate, that they knew it all before. Its editorial opinion is as follows:

Is the illuminating engineer a necessity? Mr. Leon Gaster, in a paper read before the Society of Engineers - in - Charge, thought that such an individual was in urgent demand; but, on the other hand, a majority of the speakers who took part in the discussion thought quite the reverse. For ourselves, we are inclined to agree with the latter. It sems to us that the art of correct illumination should be understood by the station engineer or contractor, and that there is no room or need for a "profession" to spring up devoting its whole attention to questions of illumination. On the face of it, illuminating engineering seems to be a topic with no beginning or end, while the writing and speeches of "illuminating engineers" only seems to make confusion worse confounded. It is all very well to talk about physical constants, units of light—the lumen, the lux, and the candle foot—but above all, sight must not be lost of the physiological aspect of the situation, and while man remains the obstinate, unreasonable animal that he is, this physiological side will always be on top. There is no shadow of doubt that many lighting installations, whether making use of electricity, oil, or gas, could be improved; neither do we for one moment dispute the difficulties connected with the proper illumination of large buildings in the shape of churches, public halls, and so on; but the knowledge required for such installations is largely a matter of experience, and is an art which can never be reduced to the 2 and 2 make 4 aspect of an established science.

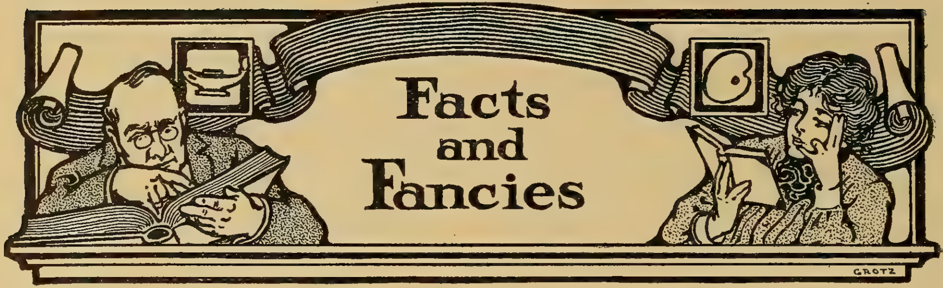
There is little doubt that in questions of correct illumination an ounce of experience is worth a cart-load of theory. A man may appreciate the exact significance of all those beautiful unit terms which have been so laboriously introduced by the illuminating engineer, yet if we had a church to illuminate we would prefer to depend on the *experience* of a contractor or station engineer who had executed church installations before, rather than upon the illuminating engineer with his portable photometer, samples of paint, and book of rules.

Further commenting on an article on "Industrial Lighting" in a recent issue of *The Illuminating Engineer,* the editorial says:

Do we require an illuminating engineer to tell us this—or will the contractor with the knowledge of past experience give us as good advice? We labor under the impression that he would.

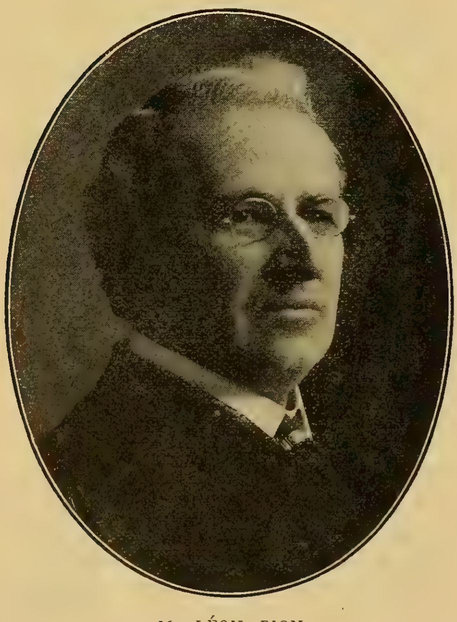
"It is true that a great deal of the work of the illuminating engineer will, for some time to come, be the mere carrying out of what is obvious apparently. It is an undisputed fact that what should have been suggested by mere common sense and experience has by no means been put in practice; there is no defect or incongruity so self-evident that it is not found over and over again in actual use. We cannot speak from personal observation as to conditions in England, and it may be that all the principles of good lighting have been carried out there time out of mind; but from information and belief, based upon personal and published testimony, our conclusion is that general practice there is not materially better than in this country.

Mr. Gaster is indeed right in pointing out the patience which will be required on the part of those seeking to establish illuminating engineering as an independent science. It is only a score of years ago that electrical engineering was in the same position; and while we do not infer that illuminating engineering will ever be as wide and comprehensive a science as electrical engineering, it will nevertheless make a place for itself the world over.



Is the Lighthouse to Become a Thing of the Past

The lighthouse, which has so long held a cherished place in the lore of the sea, as well as a position of vital importance in navigation, is in imminent danger of being left as a mere monument of a by-gone age, like the stranded hull of some old wooden warship. By the use of a system recently patented by an American inventor, the navigation of harbors and waterways will become as simple and pleasing a task as walking up the "Great White Way."



M. LÉON DION.

The inventor of this ingenious scheme is Mr. Léon Dion, of Wilkes-Barre, Pa., who has fully protected his invention by patents in all the countries of the world. The patent, by the way, is of peculiar interest in that it is one of the few absolutely fundamental patents; and, as in the case of all revolutionary inventions, the method is so simple and so apparently obvious, that it is almost inconceivable that it has not been thought of before. It consists briefly of a cable, having connected at suitable intervals short branches to which are attached incandescent electric lamps fitted with reflectors which will concentrate the light into parallel beams as nearly as possible, the whole system of course being designed to withstand the pressure and corrosive action of sea water. The lamp and reflector are made sufficiently buoyant so that they will maintain an upright position. The cable thus equipped is then laid in the proper position in the waterway to be lighted up, and connected with a source of electric supply from shore. The illustration will give a clear idea of the method. The course of the channel will thus be marked out by brilliantly lighted spots on the surface of the water. It is a well-known fact that even the highest waves do not produce any disturbance a very short distance below their own depth. The cable with its connected lamps will therefore always be in practically still water.

DION'S "SUBAQUEOUS" SYSTEM OF HARBOR LIGHTING.

The only condition under which this system would seem to be unavailable would be in river channels or other places where the water might be roilly. In all ocean harbors or roadsteads there is apparently nothing in the way of its successful employment, and this is the view taken by numerous naval and navigation authorities of the highest rank. One of the most important features of this system is the fact that it offers equally as good guidance in the densest fog as in perfectly clear weather. Fog and wind practically never occur together, and the beam of light would therefore project from the level surface of the water up through the fog, so that the vessel would be guided by pillars of fire, like the Israelites of old. By the use of what is known as a water telescope, which is simply a tube having an observation glass that can be dropped beneath the surface of the water, or by the provision of a bull's-eye inserted in the hull of the vessel below the water line, it would be possible to guide the ship without reference to the surface light on the water.

The rapidity with which such a system can be laid in any harbor, and the fact that it is absolutely controllable with a simple electric switch at any point on shore, renders it a most valuable aid in time of war. For example, if the entrance to New York harbor were outlined by this system, it would be a simple matter to light any particular vessel on its way in or out, and extinguish the entire system when the vessel was safely beyond the need of such lighting. A well-known United States Army officer, who was detailed to study the Russo-Japanese war, and who has been shown the working plans of this invention, says that if Russia had been in possession of this system the Japs could never have taken Port Arthur, as the harbor could have been so thoroughly mined that it would have been utterly impossible for a Japanese vessel to approach without being blown up.

As compared with the cost of lighthouses, the system is so inexpensive as to be positively laughable in comparison.

In contemplating this improvement, which is fraught with such wonderful practical possibilities, the imagination may easily be led to less dignified if not less interesting flights. Here is a new field for the advertising man. Having covered rocks, trees, billboards, blank walls, and house-tops with signs and electric displays, and even having projected his advertisements on to the clouds, the expanse of ocean is now open to the exercise of his genius. We may easily conceive ourselves promenading the new White Way laid out through Long Island Sound, and admiring the legends apprising us of the merits of various beers, whiskies, and table waters, shown forth in sparkling letters of light upon the face of the deep. Then indeed will the advertiser have possessed the earth; but why shouldn't he?

Light Versus Dark Symbols in Printing

By Albert J. Marshall.

From the earliest times it has been the custom to use some dark fluid, commonly spoken of as ink, in making symbols in printing. This use of dark printed symbols on light surfaces was doubtlessly owing to the fact that it was easier to make a marking fluid of a dark hue than of a light tint. When the printing press was introduced the natural course was to continue to use the familiar black ink, and light or white surfaces.

The eye "sees" an object when light rays are reflected from the object to the eye. It is not the amount of light rays falling on an object that produces vision, but the amount of light rays that are reflected to the retina of the eye. In view of this law of vision, are we not "seeing" in an *indirect* manner, rather than a *direct,* if we consider the present method of printing? In reading a newspaper, for instance, or other printed matter which has black letters on a white surface the eye "sees" by the amount of light rays which are reflected from the page as a *whole,* and *not* the amount of light rays which may be reflected from the print.

We are accustomed, when speaking of a student, to consider him as a man who require the use of glasses. Some people maintain that this is caused by the wrong use of artificial light; others that it is brought about by the constant strain of the eye in reading fine print. There is undoubtedly much truth in both of these views; but the writer feels that *one* of the principal causes for such conditions of weak eye-sight is the eye having to receive the reflected rays from the entire surface, less the space taken up by symbols, instead of receiving the fewer light rays which would be reflected from the letters themselves. In other words, the eye is compelled, in order to read a printed word in dark ink on a light surface, to receive the reflected rays from everything other than that it desires to see, and by so doing is tired and strained.

It is rather amusing to note that oculists, to whom we expect to look to for advice in such matters, are numbered among such offenders, in that the cards that they use in "testing" the eye have these same old black letters and numbers on white backgrounds.

It is not the writer's desire in this paper to specify the proper combination of shades or colors for symbols and backgrounds, but rather to draw

to the public's attention the possible value of considering the use of light characters on dark backgrounds, instead of dark characters on light backgrounds, as are now in vogue. By the use of the former combination the eye is not compelled to receive the reflected illumination from a comparatively large surface in order to "see" the print, but to "see" the object itself, *i. e.*, the printed characters by having them reflect the light to the eye, the background being of some soft, restful hue or shade, which will serve to rest rather than to strain the eye.

One of the most efficient signs that has been used in recent years is that of the Postal Telegraph Company, which consists of a dark blue background with white lettering. It can be seen with great distinctness from a considerable distance, and, when read at short distances, is exceedingly easy and agreeable to the eye. This arrangement of colors is far easier to the eye, to say nothing of the artistic side, than one with a white background and blue lettering would be.

The reader will doubtless have observed the general tendency to use dark backgrounds and light lettering on large display signs. Such signs are now being used with great success for night as well as day display, the lettering being illuminated by concealed trough or reflector lights. This type of sign is far more effective, and can be seen at greater distances, than the old style of black-on-white sign.

The idea of printing newspapers, books, etc., with white or light inks on black or dark paper may seem to be very far fetched; but it is the writer's firm conviction that, while the time may not yet be ripe for such a change, within the next few years there will be a decided tendency to carry out this idea.

Alleviation of Pain by Light

Experiments are in progress at the New York Skin and Cancer Hospital for the alleviation of pain by the use of intense light. So far the physicians are unwilling to express any definite opinions as to its efficacy, and content themselves by saying that their hospital tries every device which promises to be of assistance in curing or alleviating cancer. The results with the "light cure," however, have been sufficiently satisfactory to induce them to continue the experiments.

The patient is subjected to what is known as the lucidescent light. It is the ordinary electric light of 500 candle-power, focused by parabolic reflectors on two spots. It is turned upon the seat of pain for 15 or 20 minutes at a time, and much care has to be taken to prevent the burning of the flesh. The treatment is repeated two or three times at intervals of three or four hours, and in many cases the pain is reduced or driven away for several hours afterward.

So far the hospital physicians say they cannot explain in what way the light acts. They do not think it has any therapeutic value aside from the relief of pain, but they find it very useful for that. One of them said that he tried it upon himself for a raging toothache, and had found it drove the pain away for several hours.—*New York Times.*

Peculiar Action of Nernst Glowers

The broken filament of a Nernst lamp, says Mr. James Swinburne, in a Royal Institution experimental discourse, will have its pieces welded together again when heated, so to speak, by the current. It was also shown that the originally solid Nernst rod gradually turns into a tube owing to a peculiar shrinkage, in the course of time.

The Candle Industry

According to the calculations of one of the best-informed manufacturers of candles in Chicago, over 130,000,000 lbs. of tallow are used every year in the manufacture of candles in the United States. And yet some of the central-station companies have stopped their canvass for new business!

Correspondence

From Our London Correspondent

It has for some time past been admitted that a cheap, and satisfactory method of testing mantles was much needed. The apparatus required to be light and portable, such an apparatus has now been perfected; it appears to meet all the requirements of those who desire to test the strength, durability and capacity of mantles, to resist the great strain caused by repeated lighting and extinguishing.

The apparatus, which is illustrated, is the invention of two well-known gas engineers, Mr. H. W. Woodwall and Mr. P. G. Moon. Briefly put, the tester consists of a brass standard, in which is formed the body of a cock or tap, the plug of which carries a spurred tooth wheel at the end. Upon each end of this plug-spindle is carried a four tooth corn wheel set in such a manner that the cams on either end of the spindle are not exactly opposite each other. On the top of the standard, there are fitted two pairs of uprights, in which two spindles are arranged, these are free to rise or fall, carrying on the lower end rollers made of hardened steel, which engage with the cams; on the top of the spindles provision is made for fitting weights of various sizes. The top of the upright column is fitted with a long tube having at its lower end a cross-piece which is fixed to the tube, on this the sliding spindles, carrying the weights, are free to drop when the plug and consequently the cams are involved. By this means a succession of shocks numbering eight for every revolution of the plug-spindle, are transmitted to the cross-piece, and so through the long upright pipe to the burner and mantle.

In addition to this, it will be understood that as the plug revolves in the body of the cock, the gas is alternately lit and extinguished, thus subjecting the mantle, as far as possible to the same conditions it encounters when in actual use; the mantle is continually receiving shocks, the intensity of which may be varied according to the weight which is put upon the spindle. The lighting and extinguishing is effected by means of a small bye-pass placed parallel to the upright tube. On one end of the spindle, that carries the cam, there is fitted a wheel, that is geared with the train of wheels of the index for the purpose of ascertaining the number of revolutions; the hands of this index are "sochetted" in order that they may be set at zero after each test.

The apparatus is provided with two upright standards—one for testing inverted mantles and another for the ordinary "C" or upright mantle. Should it be desired, the apparatus can be fitted with any form of burner, so that different types or sizes of mantles may be tested.

A spur tooth wheel, at the other end of the plug of the cock, permits the

tester to be driven by any form of motor. In the particular tester illustrated a water wheel especially designed and made has been adapted, being, the inventors consider, the simplest and cheapest method of obtaining the necessary power. To this motor, is attached a tap and flexible tube sufficiently long to connect to any convenient source of water supply; no connection is supplied on the outlet, as it is best to allow the water a free exit. The speed at which the apparatus is driven can easily be regulated by means of the tap fitted on the inlet to the motor; it has been found, we understand, that about 30 revolutions of the spindle per minute gives the most satisfactory tests. It will be quite understood that in comparing results, it is very necessary to watch that they have been obtained approximately with the spindle running at the same number of revolutions per minute.

So much for the description of this mantle tester, which is being operated

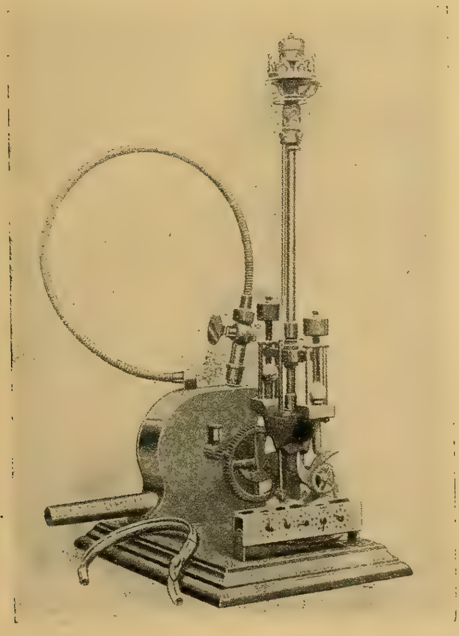


FIG. I.

in this country for the inventors, by the well-known firm of gas meter makers, Thos. Glover & Co., Ltd., who are sole licensees. It is a very beautifully made apparatus, and will, we are sure, in a very short time be used extensively. (See Figure 1.)

The method adopted in testing mantles with the tester is as follows:

The burner, whether vertical or inverted, is attached to the machine, and the mantle placed upon it; the cock or taps must then be turned round to such a position as will insure the gas passing under the mantle. The mantle is then lighted and allowed a short time to harden; this having been done, the hands of the index are set at zero and the machine started; it should be run with light weights upon it, observation being kept on the mantle, to note when it shows signs of breaking; should the mantle stand the test, with the light weights, it will be necessary to put on gradually heavier weights until the most satisfactory weight for testing the mantle is reached. Experience proves that weights of about 2 ounces are most satisfactory for general use. It is of course possible to test the mantles up to the point of complete destruction, either by shocking lighting and extinguishing simultaneously, or the gas can be extinguished and the machine used only for giving shocks; or the shocking arrangement can be put out of gear; the two short pieces supplied are only used testing the mantle as to its capacity to stand lighting and extinguishing.

Whilst dealing with the question of mantles, we might draw attention to a note published in the *Journal fur Gasbeleuchtung* from the pen of Dr. Barenfanger, describing an apparatus designed by Dr. Kruss, for observing and recording progressive deformations of incandescent mantles.

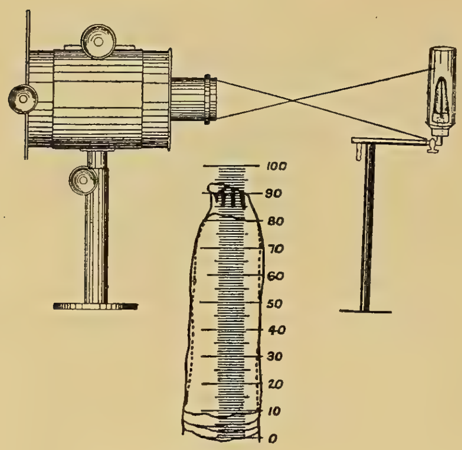


FIG. 2.

The apparatus consists of a camera with rising and focusing adjustments, and a graduated ground glass made to rock upwards or downwards by means of a milled head, seen on the left in the illustration. The camera is fastened rigidly on a base at a fixed distance, say 8 inches, from the stand carrying the mantle under observation. Four marks are made on the burner at horizontal angles of 90 degrees apart. Each of these marks are successively turned towards the lens of the camera, the image of the mantle is focussed accurately, a piece of oiled or waxed paper is laid on the screen, and the outline of the mantle is carefully drawn upon it. (See Figure 2.)

After the mantle has been alight for the prescribed time, the whole operation is repeated, each new drawing of the mantle being made in dotted lines upon the corersponding original. If the mantle is tested when new and after use on the photometer in the same four positions, values are obtained as to the loss of illuminating power caused by the deformation indicated on each double drawing, the graduations on the screen permit records to be kept of the different, and particular parts of the mantle which are not brought to a state of full or perfect incandescence.

From time to time we have drawn attention in our letters to the advances made in street lighting on this side. We have before us some interesting particulars of the improved public lighting of the city of Edinburgh supplied by Mr. W. R. Herring, M. Inst., C.E., Chief Engineer of the Edinburgh and Leith joint Corporation Gas Undertaking. Until quite recently the standard of illumination considered sufficient in Scottish towns was a very low one; although gas of a high candle-power is almost universally sent out from the gas works in North Britain. In Edinburgh Mr. Herring had many difficulties, and prejudices to overcome; and his present achievements are the "consummation of eight years' hot controversy" wherein, as he says, at the outset, the strongest elements were arrayed against him, including members of the Gas Department itself. The initial difficulty in introducing incandescent gas lighting into Edinburgh was, what may be called, for want of a better term "use and wont"; what had been, and was, was good enough and in the opinion of many of the "canny Scotts" should therefore be allowed to remain. Another, and even greater difficulty was that the prescribed rate of gas consumption per lamp was an unalterable quantity so far as the corporations were concerned. This was fixed at *two cubic feet per lamp* per hour. No doubt to those in America, who are still using flat-flame burners, such a statement will seem absurd. Mr. Herring never ceased agitating, and he succeeded in gaining the permission of the gas commission to put up several installations in different parts of the city and showed what could be done in the way of improved lighting by gas. So successful were these ex-

periments that the Lighting Department were forced to take up the question. They gave way in regard to the question of quantity per hour, per lamp and conceded somewhat grudgingly to the rate per hour, being increased to 2¼ cubic feet per lamp. Many experiments were made, with burners, mantles and lamps till finally Mr. Herring succeeded in obtaining a duty of 30 candles per foot of gas consumed using; in a specially constructed lamp on inverted incandescent burner, which with a consumption of 2¼ cubic feet of gas gave an illumination equal to approximately 70 candles; compared with at the most an illumination of 7 candles for the previously prescribed 2 cubic feet consumed in the old days when flat-flame burners were used. The type of lantern originally in use was quite unsuitable for the delicate inverted burner and mantle, so that new lanterns had to be installed, involving a fairly large capital expenditure, but the result has been highly satisfactory and today the cities of Edinburgh and Leith are in the front rank, so far as the gas illumination of their streets is concerned. We have the figures for the year ended 15th of May, 1907, when there were 9,940 incandescent gas lamps and 1,175 electric arc lamps. We are only concerned in this note with the lamps using gas and the following is an analysis of the gas per hour supplied:

3.508	 3	" "
1.080	 2	feet burners
5.352	.... 2¼	" "
3.508	 3	" "

Total .. 9.940 on average consumption of 2.489 cubic feet.

Since the date of the report many improvements have been made and the average consumption, as we have already mentioned has been reduced to 2¼ cubic feet per lamp per hour.

It may be interesting to note that the total cost of the 1.175 electric arc lamps during the year ended 15th May, 1907, was £10,575 ($50,760.00). These arc lamps displaced 4,095 gas burners which would have only cost the lighting authorities, with a consumption of 2½ cubic feet of gas, at 2s. 0d. per cubic foot, 48 cents a luminosity of 70 candles—£4,019 ($19,290.20). Whether in course of time gas, and the inverted incandescent burner will entirely take the place of electricity for street lighting we cannot, of course, predict, but it is certain that should such a decision be made the lighting rate would be greatly reduced.

Illuminating engineers may well turn their attention to the important question, what is the best position for lamps to be placed in order to obtain even illumination? A very general distance between lamp standards with us is 22 yards, the standards on the opposite side of the road being placed at intermediate distances; a general height is 11 feet from the pavement line to the underside of the lantern. Many special lanterns have been designed for upright incandescent burners; perhaps one of the most popular is that known as the "Westminster." This is square, or plain, and measures 17 inches at the widest part, fitted inside with a porcelain reflector. This is necessary in order to throw down the light. A series of tests have been made by the lighting surveyor of a large London Borough with lanterns of this type, and he reports that with two Welsbach burners, each consuming 3.2 cubic feet per hour, using 12.65 mantles per burner, per year the cost per annum was £1 17s. ($8.88).

CHAS. W. HASTINGS.

Commercial Engineering of Illumination

The Business Outlook

We have all heard exactly what caused the recent financial panic. Considering the number and gravity of these causes as given by various authorities, the wonder is that there is a single business or financial institution left to tell the tale. They all agree, however, on one general point: that the basic conditions for business in this country are, and have been, sound. The fact is that business has been much more scared than hurt. The following opinion of the president of a company which is in position to know general conditions, will be read with interest:

"It is daily becoming more apparent," said President W. H. Whiteside of Allis-Chalmers Company, in a recent interview, "that the general business of the country has not been so seriously injured by the recent sudden financial depression as the public has been inclined to believe. And I am firmly of the opinion that the thing now most necessary is to loosen the chains of conservatism and give courage an opportunity to assert itself and make advances consistent with the general prosperous conditions and well distributed resources of the country. As the production and use of basic machinery, such as prime movers for the generation of power, is a very potent and a leading factor in our commercial activities, very naturally it is one of the first lines of business to be affected when the pendulum swings from optimism to pessimism, and likewise the first to feel the effect when the change in sentiment again manifests itself. The number and character of inquiries which our offices located in the principal commercial centers of the country have recently been receiving convincingly demonstrate a return of confidence, and bear evidence that not only a diversified but a large volume of business will be offering ere the middle of the first quarter of 1908 has been passed.

"Until within a few months manufacturers everywhere in the United States found themselves urgently in need of increased facilities for carrying on their own business, and when they are again called upon to supply the normal demands of business, and to replenish stocks in the hands of jobbers and retailers, many of which are now nearing the point of depletion, they must, of necessity, again work their plants to the full of their present capacities, and add increased machinery equipment, the plans for which in numerous instances are already well matured.

"The railroads of the country, whose policy of retrenchment has continued for approximately a year, notwithstanding the largest offerings of traffic, with resultant increased earnings, in their entire history, must shortly be compelled to again enter the market and make large expenditures for renewals, including train equipment, steel rails and general supplies. This coupled with the approaching need for the renewal of stocks of metal employed in all branches of industry, which, through shut downs of furnaces and smelters and the continued use of iron, steel and copper for current consumption, have now been lowered very near to the minimum, and giving due consideration to the large balance now in our favor in our commerce with foreign nations, and to the well distributed revenues from our exceptionally large agricultural products, cannot fail to create an early demand for new machinery and auxiliary equipment.

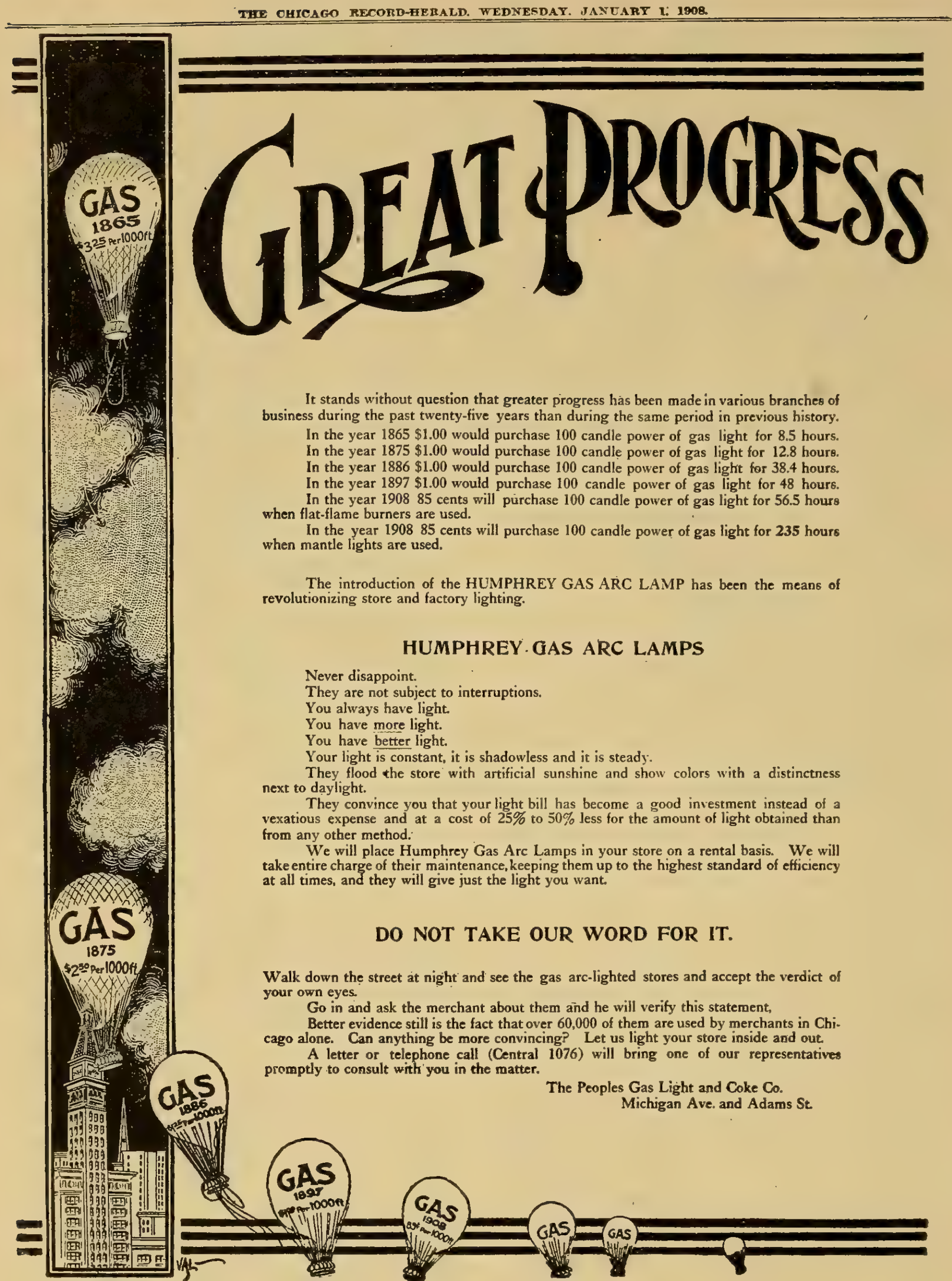
"The outlook is therefore distinctly encouraging."

FEEDING THE GOOSE.

"Killing the Goose."

Our English contemporary, *Electrical Industries,* in reproducing the cartoon used in our last issue, makes the following remarks, which apply to America as well as to England:

Everybody admits, without argument, that it is very foolish to chop off her head so long as she goes on laying bullion. But, with the perversity of human nature, people commit this type of murder over and over again. Who has not heard a manufacturer say, when trade is bad: "I cannot afford to advertise," and, when trade is good, "I do not need to advertise"? And if he is already spending money on advertisement, his first action, should business slack off seriously, is to reduce expenses by stopping his advertising. In central station publicity the same policy is, if anything, more common. Expenditure on advertising is regarded as an excrescence, a parasitic growth which may be ornamental but is certainly deserving of being cut away ruthlessly as soon as the pinch of adversity is felt. Even in normal times money is grudged to the publicity department, and the control is entrusted to a poorly paid and inexperienced man who illustrates the law of cause and effect by working spasmodically and without enthusiasm. The indifferent results are then laid at the door of publicity, and not of the inefficient manner in which the policy of advertisement has been carried out. However, there is a growing recognition of the fact that a well-organized and well-equipped publicity department is an integral part of an up-to-date electricity supply undertaking, and is particularly needed when financial and other difficulties are most pronounced.



THE CHICAGO RECORD-HERALD. WEDNESDAY. JANUARY 1, 1908.

GREAT PROGRESS

It stands without question that greater progress has been made in various branches of business during the past twenty-five years than during the same period in previous history.

In the year 1865 $1.00 would purchase 100 candle power of gas light for 8.5 hours.
In the year 1875 $1.00 would purchase 100 candle power of gas light for 12.8 hours.
In the year 1886 $1.00 would purchase 100 candle power of gas light for 38.4 hours.
In the year 1897 $1.00 would purchase 100 candle power of gas light for 48 hours.
In the year 1908 85 cents will purchase 100 candle power of gas light for 56.5 hours when flat-flame burners are used.

In the year 1908 85 cents will purchase 100 candle power of gas light for 235 hours when mantle lights are used.

The introduction of the HUMPHREY GAS ARC LAMP has been the means of revolutionizing store and factory lighting.

HUMPHREY GAS ARC LAMPS

Never disappoint.
They are not subject to interruptions.
You always have light.
You have more light.
You have better light.
Your light is constant, it is shadowless and it is steady.

They flood the store with artificial sunshine and show colors with a distinctness next to daylight.

They convince you that your light bill has become a good investment instead of a vexatious expense and at a cost of 25% to 50% less for the amount of light obtained than from any other method.

We will place Humphrey Gas Arc Lamps in your store on a rental basis. We will take entire charge of their maintenance, keeping them up to the highest standard of efficiency at all times, and they will give just the light you want.

DO NOT TAKE OUR WORD FOR IT.

Walk down the street at night and see the gas arc-lighted stores and accept the verdict of your own eyes.

Go in and ask the merchant about them and he will verify this statement,

Better evidence still is the fact that over 60,000 of them are used by merchants in Chicago alone. Can anything be more convincing? Let us light your store inside and out.

A letter or telephone call (Central 1076) will bring one of our representatives promptly to consult with you in the matter.

The Peoples Gas Light and Coke Co.
Michigan Ave. and Adams St.

The above is a reproduction of a full-page advertisement which recently appeared in a Chicago newspaper. This is the Gas Company to which we have referred as inaugurating a systematic and aggressive policy for promoting the use of gas for lighting. The advertisement is not only commendable for its size, but for the excellent arguments which it sets forth.

Wireless Cluster Litigation Ceases

It was stated in our last issue that, by a recent decision of the United States Circuit Court of Appeals in the case of the Benjamin Electric Manufacturing Company against the Dale Company, for infringement of patent, the Benjamin patents had been sustained. We have recently been advised by the Dale Company that they have concluded an arrangement with the Benjamin Electric Manufacturing Company whereby the Dale Wireless Cluster will hereafter be manufactured and sold by the Dale Company under a license from the Benjamin Electric Manufacturing Company, and that all claims for damages that might arise from previous sales have likewise been settled. The Dale Wireless Cluster may therefore be purchased with the absolute assurance that no litigation for infringement will follow.

Window and Store Lighting

We have received from the Publicity Manager of a lighting company in a large Western city the following contribution under this title. The writer stated that the matter presented has been used as a sort of "primer" for the solicitors of the company. He also stated that the solicitors found much of the matter contained in The Illuminating Engineer too technical for their comprehension. The contributor, further stated that his previous experience had been in strictly literary work, in connection with the daily press.

The text of this communication is interesting for several reasons. We are assured that the solicitors have found it a valuable help in their work; it is a fair inference that it gauges the knowledge and receptivity of the average solicitor on the subject of illuminating engineering. This is by no means a criticism of the solicitor's ability; it simply brings out the fact that the average lighting company solicitor is chosen first as a salesman, and uses the same methods in selling light that he would use in selling shoes, or books, or any other standard article of merchandise.

Correct distribution and natural color are the essentials of window lighting.

If the light is not properly distributed, the effectiveness of the display is lost. If the colors of the goods exhibited are changed by the illuminant, the sale of these goods is hurt, the value of the whole display is lowered.

This means that electric light is necessary for window displays.

Electric light is the only artificial light known that contains all of the illuminating elements of sunlight. It is, in fact manufactured sunlight. Therefore, it is the only light that will not change the colors of goods, but will show them in the same shades and hues as they appear in natural light. It is the only light that can be evenly and perfectly distributed so that every corner of the exhibit may be equally attractive.

There are no dead corners, no dark spots, where electric light is used.

There are many ways in which show windows may be lighted with electricity. Large stores which have windows in long series often make especial arrangements of the lights to suit each succeeding display, but small stores with only one, two or three windows do not find this to their economical advantage. They generally desire a fixed arrangement of lights.

Experience has shown that where the window is encased, as are most windows for the display of dry goods, millinery, shoes, haberdashery, clothing, silverware, hardware, books, pictures, and stationery, a very excellent effect is obtained by studding the ceiling of the window with sockets and reflectors for incandescent lamps of low power, four, eight, or ten candle. This permits a greater number of lamps to be used at less cost than could be if the larger lamps were installed, and results in more generally diffused light, a light that is equal in all parts of the window, instead of in a series of brighter streams from more widely separated centers, which are bound to be alternated with darker belts and to produce an uneven effect, making the display less effective. For large win-

dows reflected light at the top of the panes, concealed behind a painted board, are excellent. Also when an encased window is properly wired and ventilated it will not frost, and when through any defect or improper ventilation a window does frost, a few moments working of an electric fan will clear the panes. This is true of no other kind of lighting.

For windows that are not encased, and especially for those whose displays are confined to the lower part of the window, it has been found that a handsome fixture suspended from the ceiling to the center and casting downward a properly diffused light from a cluster of small incandescent units, or a high efficiency lamp, gives the best effect, though, in many cases, the addition of side lights concealed behind the casings add greatly. This center light not only lights the window and its display, but aids greatly in the illumination of the store. In drug store windows there should be a small incandescent lamp behind each of the colored jars.

A little study given the matter of window lighting before service is adopted, will result in effectiveness of the lighting and financial economy. It will also show that electric light is clean, does not create heat when used in enclosed windows and does not produce, under any conditions, the smudge inseparable from open flame lights. When the lamps are arranged in the ceiling or in reflectors behind the lintel casing, the light is all thrown downward, and not one ray is lost or wasted. When they are arranged behind the side casings or concealed elsewhere, the light may be reflected at any desired angle with full efficiency. This is possible only with electricity.

All classes of electric window lights may be connected with time switches and by these switches, operated by clock-work, automatically turned off at any hour desired —a great saving in expense and care.

Electricity is not merely the best light, but is the ONLY really efficient light for show windows.

STORE LIGHTING.

The essentials of window lighting are the essentials of store lighting—natural color and correct distribution. This, as in the case of the window, can only be had in its perfection, by the use of electricity. Many merchants have found that the better and more perfect their store lighting the better becomes their trade. This, no matter what line of merchandise they were handling.

Perfect lighting in stores need not mean elaborate outlay to start with nor increased expense to use,—unless the original installation was very poor and very inefficient,—and the betterment and increased trade pays for such increased cost and expense as may exist. People want to see the things they are buying and the store that best shows them those things will do the business.

There are as many different ways of lighting a store as there are different stores to light. Every little thing enters into the proposition and must have consideration—the number, size, and arrangement of windows, character and color of ceilings, of walls and fixtures, color, size, number and disposition of counters and show cases and character of goods comprising the stock.

In order to secure the most efficient lighting in a store it is best to see an expert lighting engineer before any plans are drawn.

Most companies will be pleased to have an expert look over any store or the plans for any proposed store building, and advise with the proprietor as to the best light, which means most efficient and economical. He will take into consideration all the elements in the problem and solve it for you. This is in regard to fixtures and their arrangement.

In regard to kind of light there is but one answer. Electricity. Because—

It is manufactured sunlight and has all the color elements of the sun.

It does NOT heat the store in warm weather.

It does NOT vitiate the air by consuming the oxygen, but leaves it fresh and sweet.

It does NOT give off carbon dioxide or any other gas that begrims ceilings and smudges woodwork and goods.

It does NOT require matches with their danger of fire.

It does NOT strain the eyesight by flickering or uneven glare.

It does NOT flicker when an open door causes a draft.

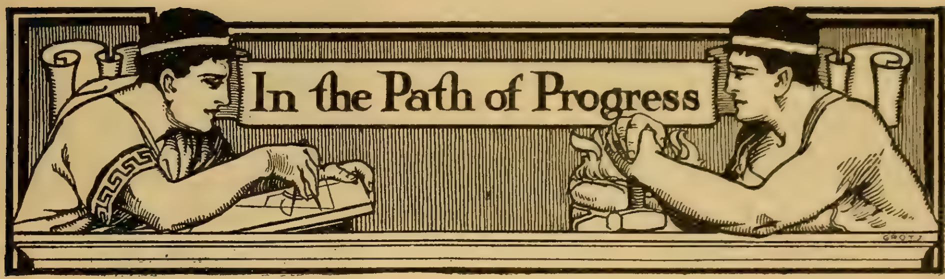
It does NOT waste a part of its illuminating force on the ceiling, but casts it all downward or can be reflected as desired.

It does NOT make heavy shadows beneath the fixture.

IT IS the only light that can be safely used in closets and close corners, under counters and among the goods.

IT IS the only always safe, clean and comfortable light.

IT IS the PERFECT light.



Reflectors for Window Lighting

While illuminating engineers may differ as to the best means for the general lighting of a store, there is practical unanimity of opinion as to the best method of lighting show-windows. The method is commonly expressed by the term "concealed lighting," and is accomplished by placing the light units in such a position that they cannot possibly be seen by the outside observer. Reflectors are an essential thing for this system, serving the purpose of both hiding the light units, and of projecting the rays of light in the desired direction. As the distribution of rays is required within a limited space, mirror reflecting surfaces are the best, and for these the familiar silvered glass furnishes the best material.

Where the goods are displayed on or near the bottom of the window, as in the case of jewelry and other small wares, the system of placing the reflectors within the ceiling, which if necessary may be a false one, is the best method. Where, on the other hand, the windows contain goods which necessarily require some height for their display, as men's and women's clothing, tapestries, etc., the so-called "trough reflector" placed in the upper angle of the window, will give the best results. The general acceptance and use of these devices have made them familiar to all. Nevertheless they have been worked out for their various purposes and perfected with a degree of care and skill commensurate with their usefulness. Among the oldest and best-known manufacturers of this line of goods are Mr. I. P. Frink, and Mr. Nelson Weeks both of New York. The extent of public appreciation of these goods may be realized from the fact that of the trough reflectors manufactured by Mr. Frink alone there are over 200 miles in use. Of course, this is not confined to store window lighting, but includes picture gallery illumination, and other similar purposes. In fact, these two manufacturers may be considered constructing illuminating engineers in this specialty, as their work is by no means limited to stock forms and shapes, but includes the design of reflectors to meet special problems. As an example of this, Mr. Weeks mentions the case of the familiar show windows of the United Cigar Stores Company. This company goes into every detail of its business with extreme thoroughness, and therefore made careful experiments with various types of show-window reflectors. All of the regular types, however, failed to illuminate the transparent sign which is invariably used along the top of windows. Mr. Weeks designed a special type of reflector for this purpose, which, while throwing the strongest light below on to the goods displayed, threw enough on to the upper portion of the window to illuminate the transparency. Inci-

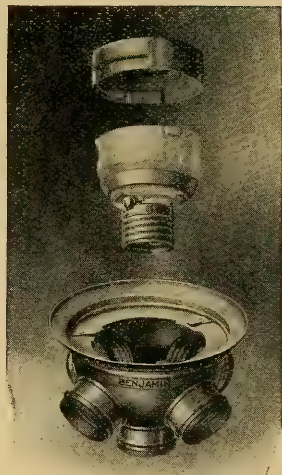
dentally, the distance of the lamps in the reflector was increased from 7 to 12 inches, with satisfactory results. The utilization of the upper part of the show-window as a transparent sign is a matter of no small importance, especially with stores having an evening trade, such as cigar stores, drug stores, confectionery stores, etc. Mr. Weeks is the only manufacturer of this particular design of trough reflector.

Other reliable manufacturers of this line of reflectors are as follows: Sunlight Reflector Co., Brooklyn; Wheeler Reflector Co., Boston, Mass.; Klemm & Co., Philadelphia; Overbagh & Ayres Mfg. Co., and American Reflector & Lighting Co., Chicago.

A New Wireless Cluster

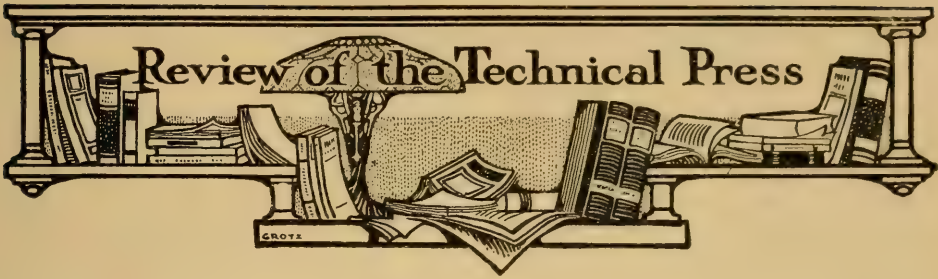
The United States Courts have recently pronounced Mr. Reuben Benjamin the inventor who made the so-called wireless cluster a practical commercial article. In the words of the judge: "His invention was novel, ingenious and meritorious," in proof of which he cites the fact that "the Benjamin cluster immediately entered into commercial use"; and he might have added "has continued to increase in use and at an amazing rate since its first introduction."

As great an improvement as was the wireless cluster over the old cumbersome arrangement of individual sockets attached to a central support, Mr. Benjamin has not been content to let well enough alone, but has given incessant study not only to the improvement of the cluster, but to the design of other devices that would facilitate electric lighting. The latest result of his labors in this direction is the new separable cluster. The general construction is shown in the illustration, which shows the three essential elements, namely: base, insulator,



and body. This construction greatly facilitates wiring, renders a change in the number of lamps used a simple matter of change of body, and avoids the necessity of rewiring in order to put on or change a reflector. Another improvement is in an arrangement of the lamp sockets so as to take the standard size shade holders. These improvements constitute the last word in cluster lighting.

The illustration below shows the new cluster with a special decorative treatment. With frosted lamps of the spherical shape used in such a fitting, a light unit of simple but very tasteful design is produced.



American Items

New Books

The Colorado Springs Lighting Controversy, by Henry Floy; Illuminating Engineering Publishing Company, New York. $4.00 net. Postage, 25c.

This is a complete history of this important case, containing a digest of the legal arguments, and a reprint in full of the expert testimony which was given at the hearing. The foremost authorities on lighting in this country gave testimony covering every theoretical and practical phase of the subject, and the book is therefore an authoritative and complete discussion of the subject of street lighting, and valuable as a technical work. The award of the Board of Arbitration had the full force of a court decision, and is therefore an important opinion in regard to the interpretation of street lighting contracts, particularly those in which the old term "standard or normal 2,000 candle-power arc lamps" is used. As both a technical and legal work therefore, it should find a place in the library of every central station and city engineer.

Handbuch der Elektrischen Beleuchtung (Hand Book of Electric Lighting), by J. Herzog and C. Feldmann. Julius Springer, Berlin, 757 pages; 707 illustrations.

This new work on electric lighting is characterized by the careful, painstaking and exhaustive treatment of the subject which is peculiar to the work of German scientists and engineers. The work is particularly to be commended to illuminating engineers, and electrical engineers having particularly to deal with the subpect of lighting, in fact, the title might appropriately have been, "Electrical Illuminating Engineering." The theory of light as applied to illumination is worked out in a particularly clear and exhaustive manner, and is brought strictly up to date, all of the latest forms of electric lamps being given a due amount of consideration. While the treatment of the subject is necessarily from the European point of view there are nevertheless very few cases in which the applications are purely local. It appears to us to be the most valuable contribution to the subject of electrical illuminating engineering that has yet appeared; in fact, it is the only work on the subject, to our knowledge, which has fully recognized the importance of an exposition of the laws and principles of illumination in conjunction with the production of light. No engineer at all familiar with the German language should be without a copy.

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A Comparative Study of Plain and Frosted Lamps, by E. P. Hyde and F. E. Cady; *Bulletin of the Bureau of Standards,* Vol. 4.

The authors give the results of an exhaustive study of this subject, on which they had previously reported the results of preliminary experiments.

Cutting Down Electric Light Bills, by Geo. R. Metcalfe; *Technical World Magazine,* January.

A popular article explaining that it is economy to reject electric lamps as soon as they have depreciated in candle-power to a certain extent.

The Proper Use of Light, by W. K. Davis; *Journal of Electricity, Power and Gas,* December, 28th.

A very brief review covering the entire subject of the use of light.

Electricity in German Churches, by Dr. Alfred Gradenwitz; *Western Electrician,* December 28th.

An illustrated article describing a number of typical installations in German churches.

Innovation of Arc Lights in all Countries, by "R"; *American Gas Light Journal.* Illustrated.

Describes various installations of arc lamps in different countries.

The Problem of Color Photometry, by J. S. Dow; *Electrical World.*

A discussion of a letter and editorial comments on the subject previously printed.

Street Lamps and Illumination; *Municipal Journal and Engineer,* January.

Illustrates a large number of ornamental lamps and lamp posts as used in various cities.

Street Lighting in 1907, by Alton D. Adams; *Municipal Journal and Engineer,* January.

A review of the year's progress in street lighting.

Municipal Electric Lighting; *Municipal Journal and Engineering,* January.

Brief reports from various cities having municipal lighting plants.

Lighting of the New Plaza Hotel, by H. Thurston Owens, *Electrical World,* January 4th.

Describes the lighting installation, and illustrates the various types of fixtures used.

Some Facts Regarding Metal Filament and Carbon Filament Lamps, by George Loring; *Electrical World,* January 4th.

A comparison of the efficiencies and characteristics of the two types of lamps.

Illumination and the Architectural Treatment of Lighting Fixtures, by David Crownfield; *Architectural Record,* November.

An exceedingly interesting and well-written treatment of this important subject, illustrated with numerous examples; an especially valuable paper.

The Light of Other Days; *Southwestern Electrician,* December.

A brief historical review of early lighting, particularly of this country.

Electric Arc Illumination; *Journal of Electricity, Power and Gas.*

Illustrates and describes some of the new display lighting in San Francisco.

The Uniform Illumination of Horizontal Planes, by Alfred A. Wahlauer; *Electrical World,* December 21st.

Electric Lighting of the Stuyvesant Theatre, New York; *Electrical Review,* December 21st.

Foundation of Illumination, by Newton Harrison; *The Central Station,* December.

Foreign Items

COMPILED BY J. S. DOW.

GENERAL ILLUMINATION.

"The Province of the Illuminating Engineer" formed the subject of a very opportune paper by Mr. Gaster at the Society of Engineers in Charge on December 11. Mr. Gaster dealt broadly with the necessity for the study of illumination from the point of view of those present, remarking that the distinction between 'light' and 'illumination' had not been hitherto sufficiently realized. He also dealt with the problems of factory, shop, and library lighting, pointing out the deficiencies of the present methods adopted, and advocated the co-operation of the engineer, the architect, and the oculist. Reference was also made to the efforts of the Illuminating Engineering Society in America, and the excellent results which they had already achieved.

In the discussion which followed, the need for improvement in illumination was freely admitted, but some of the speakers expressed some doubt as to whether a society on similar lines to that in America was advisable in this country, and whether the illuminating engineer, when he arrived, would not clash with existing institutions. Time will show.

In *The Gas World* Mr. S. F. Walker deals chiefly with the limitations of the "candle-foot" as a standard of intensity of illumination (*Gas World*, Dec. 7). He rightly draws attention to the necessity for taking into account the angle at which the rays strike the illuminated surface and the amount of light reflected by the illuminated surface. Many, however, will agree with the editorial comments on Mr. Walker's article in deprecating the proposal of a new system of nomenclature involving such terms as 10,000 "rays" per square inch, etc., when we have already a carefully defined and selected set of photometrical quantities decided on at the international photometrical conventions.

Mr. Haydn Harrison (*Elec. Review*, Dec. 6) gives the results of a series of tests carried out in Cannon Street, Holborn Viaduct, Queen Victoria Street, and Farringdon Street. Cannon Street proved to be the best lighted street of the four, and Farringdon Street the worst. Some curves are also given illustrating the extremely low value of the minimum illumination which was found to occur, and the important conclusion is arrived at that the superiority of the lighting in Cannon Street is due to the better spacing of the sources of light, and not to additional expense.

Dow (*Electrical World*, Nov. 30, 1907) contributes an article on "The Problem of Color-Photometry." The author remarks that until recently our sources of light were very similar in color, but the use of "selective radiation" enables us to obtain light of very varying color, and we may eventually hope to gain greater control over the spectrum of illuminants. The point is insisted that it is naturally impossible to obtain all the desired informaton about the capablities of a source of light by any mere photometrical test, especially in the case of light of different colors. Therefore the suggested method of comparing lights which differ in color by a method involving visual acuity, is not, strictly, a photometric one, and cannot be applied to general questions of illumination. It is also pointed out that such methods are complicated by the fact that the eye is not achromatic, and that whereas the red portion of the spectrum is the best for distant vision, the contrary is the case if the detail to be viewed is at very close quarters.

The physiological complexity of the eye and its influence on color-photometry is also dealt with, the Purkinje effect and the "Yellow-spot" effect being mentioned in connection with the recent theory of the action of the "rods" and "cones" in the eye. Finally the author gives a brief *résumé* of the various methods which have been proposed to facilitate color-photometry, the natural conclusion being reached that the difficulties of the subject are only postponed, and not avoided by such methods.

ELECTRIC LIGHTING.

The Electrical Engineer (Dec. 6) contains an article by "A Lamp Maker," discussing the influence of the new metallic filaments on central station revenue. He takes a rather somber view of the situation, contending that neither the presumable increase in the number of consumers

nor their supposed increased consumption of light can make up for the direct loss of revenue arising from the greater efficiency of the new lamps. The only solution he sees lies in the adoption of some radically different method of connecting and charging.

Recent issues of the *Zeitschrift für Beleuchtungswesen* contain notes on further processes connected with the manufacture of glow-lamps; for instance a new method of exhausting the bulb by means of a small tube let into the base of the lamp. The exhaustion of the bulb and sealing in of the filament are thus carried out in one operation, and the production of the "pip"—a fruitful source of breakage—is avoided.

Walters (*Electrician*, Nov. 22, 1907), describes a B.T.H. method of increasing the resistance of tantalum filaments. The author also made experiments with the method, and succeeded in increasing the resistance of a filament from about 51 to 190 ohms. Unfortunately, the filament so produced loses its original pliability and becomes so extremely brittle as to render it difficult to secure fragments of it longer than about an inch in length. The immediate application of the method to practice is therefore regarded by Walters as somewhat doubtful.

Attention may be drawn to the recent experiments of W. L. Upson (reported *Electrician*, Oct. 25 and Nov. 1) described before the Physical Society and bearing on the chemistry and physics of the arc. The author deals with arcs between electrodes of various metals burning in atmospheres of various gases, and gives curves connecting P.D. and current, etc., and the corresponding equations similar to those obtained by Mrs. Ayrton for the carbon arc.

Guye and Zebrikoff have recently published the results of a series of experiments dealing with the same subject (reported *E.T.Z.*, Dec. 5, 1907, p. 1177).

A recent patent by Marquart describes the method of constructing carbons specially intended for the production of ultra-violet light. A small quantity of a mixture of yttrium and lead nitrates is added to the carbons, with the result that the actinic effect of the ordinary arc-light on silver bromide is increased five-fold (*Zeit. für Beleuchtungswesens*, Nov. 20, D.R.P. 176,419).

Several other articles on the subject of the metallic filament and mercury vapor lamps of interest have recently appeared which limitations of space exclude, and those will be mentioned in the list of references at the end of this review.

Gas Lighting.

The Journal of Gas Lighting for Dec. 3 contains an abstract of a recent paper by Winkler (*Jour. für Gas*, etc., Oct. 5, 1907), on the application of inverted burners to street lighting. Among other questions the author discusses the distribution of light from the inverted mantle, and the shape which ought to be given to the reflectors placed above them so as to secure the best distribution of light for street lighting. He also enters into the theory of the inverted mantle generally, commenting on the difference in the behavior of the burner in a hot and cold state, and the part played by the preliminary heating of the gas supplied to it in increasing the efficiency. He also refers to the recent improvements in the arrangement of pilot-flames attached to clusters of burners in the streets. At one time it was found necessary to have a separate pilot-flame for each individual burner, and the amount of gas so consumed was considerable. More recently, however, it has been found possible to use a single flame for the whole cluster, with a corresponding economy in the amount of gas consumed.

The *Zeitschrift für Beleuchtungwesen* for Nov. 30 contains a discussion of the theory of the action of the incandescent burner, the claims of the rival theories of "luminescence" and "temperature radiation" being considered. The experiments of Bunte and St. John on incandescent rare earths supply very strong evidence in favor of the latter theory. On the other hand there are many facts in the chemical behavior of the materials of which the mantle is composed which are suggestive of a luminescent action, for instance such mixtures of rare earths as those used in the mantle are known to readily become luminescent under the action of cathode rays, and under the influence of ultra-violet energy such as is yielded by the Bunsen flame.

Moreover the mechanical equivalent of light of the incandescent mantle approaches much more closely to that of sources which are believed to depend partly on luminéscence than sources which depend almost entirely on a pure temperature radiation. On the whole, however, the question is still a very open one, and the exact reason why a mixture of 0.8 per cent. of cerium and 99.2 per cent. theorium should act as it does remains a puzzle still.

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The writer finds the relative efficiencies in spherical foot candles per cubic foot of gas consumed to be 13 for the inverted, against 15 for the upright. In a subsequent issue of the *Journal für Gasbeleuchtung,* Dr. Dreschmidt strongly disagrees with the conclusions of Dr. Krüss, stating that the inverted burners tested were of an antiquated type.

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The Electric Conductivity of Carbides

By Dr. C. Richard Boehm.

(*Continued.*)

Even small admixtures of the carbide of tantalum as the hydrate of silicide of tantalum metal are appearance and electric properties from the normal titanium carbide filaments. I did not succeed to prepare filaments that would claimed to impart hardness and brittleness.[44] Finally titanium-carbide T. C. containing approximately 20 per cent. carbon was prepared in the electric furnace. The filaments of titanium carbide conducted the current very well. It was only advisable to proceed slowly during the process of formation with the increase of the current, as the filaments would otherwise turn spotted and burn through. The titanium carbide shows great durability and a blackening of the glass bulb was not observed even after long burning. In order to lower the contents of carbon of this carbide it was attempted to melt titanic acid in the electric furnace without the addition of carbon. It was, however, impossible to get a flux of titanic acid with low contents of carbon. The blue suboxide of titanium was formed, which is recently recommended as a material for glowing bodies. I also tried to flux in the electric furnace titanic acid and a nitrogen compound of boron. The result was a dark gray flux. The filaments formed from it conducted only at high tension. The formation of these filaments takes more time than the others. The ready-made filaments do not differ in their conduct the current at any length, even with the addition of a nitrogen compound of boron. A combination of zircon-earth with titanic acid and nitrogen compound of boron likewise led to negative results. Titanium carbide also forms a component part of the glowing bodies of Voelker[45] and Menges[46]. The German patent 162705[47] of the Deutsche Gasglühlichtgesellschaft also includes a claim on titanium forming a carbide with the carbon of the osmium paste during the process of glowing. The metal titanium is a bad conductor of electricity, however, the suboxide of titanium as the lower oxides of tantalum[48] are good conductors. Their use was recently claimed by the General Electric Co.,[49] after its utility in the arc light was demonstrated. For this purpose seven parts of rutil were reduced at 1,500-2,000° C. with one part of carbon and arc-light electrodes formed. These pencils are used as negative electrodes in combination with positive copper electrodes.[50]. To mention are also the metallic electrodes for arc light purposes prepared of ferro-titanium and patented by Isador Ladoff[51]. Also the pencils patented by the General Electric Co.[52] It is recommended to protect the electrodes of titanium-carbide with a copper tube[53]. By the same firm was proposed a combination of the carbide of boron with the carbide of titanium[54]. Siemens and Halske patented a filament of titanium wire[55] (with or without an admixture of titanium oxide as an impurity—titanium filaments are known to be arts and cannot be patented), and this was extended to include all metals of high fusibility.

Uranium-carbide is mentioned in W. L. Voelker's carbide patents and also in the glowing bodies of R. E. Menges.[56] Tungsten-carbide ought to be formed only with difficulty at the temperatures of the glowing carbon filament. This peculiarity is of great utility to the modern art of incandescent filament preparation. We will point here only to the patent of 1885 relating to it.[59]

Chromium-carbide is mentioned by W. L. Voelker in his German patent 109864[60]. He recommends chromium salts as a suitable material for coating filaments of carbon. Clegg recommends for the same purpose the salts of manganese.

Carbide of Nickel are claimed by Theodore Mace for his filaments[61].

Silicon-carbide. Some time ago I was informed of filaments made of carbide of silicon emanating from the patent mill of Voelker (Patent Schmiede). The idea of using silicon for filaments is not new, as it was expressed by A. Blondel[62] as early as 1899. However, the emissive power of such filaments could not be very high, as Léon de Somzée[63] advocated the addition of small quantities of yttrium, erbium, cerium and didymium. As the use of an organic binder was unavoidable, these filaments consisted, as all those composed of conductors of the first and second class (oxide, salts), essentially of carbides. Whether it is possible to use the nitride of silicon, which is dissociated at high temperatures, as a raw material is immaterial.[64] Blondel must have arrived at the same conclusion. In his German patent 129488[65] he describes an original glowing body, whose filament consisted of silicon and carbide silicon. In order to increase its emissive power, however, he surrounds it with a mantle of rare earths, just as Auer's mantle for gas light (thorium with true cerium). Other inven-

tors propose an inverse process, namely, to surround a carbon core with silicon compounds, as for instance Rud. Langhous,[66] Siemens and Halske[67] and I. R. Crawford[68]. Filaments of silicon carbide were recommended as early as 1894 (see English patent 18339), so that Blondel could only patent a core made of carbide of silicon.

Other propositions relate to the conductivity of silicon, in order to prepare a glowing body of a conductor of the secnd class, encased in a shell of a conductor of the first class.[69] At any rate, the German Gasglühlichtgesellschaft adds to its osmium paste (as known containing carbon) silicon[70]. The method of Wilh. Buchner[71], according to which carbon filaments are coated with silicates of Ce, Al, Zr and Be, is likewise based on the formation of a carbide of silicon. While so far all propositions to manufacture composite filaments were limited to two layers—the Actien-Gesellschaft für Elektrische Glühlampen of Budapest steps forward with a proposition[72] to add a third layer. Organic fibres are covered with a mixture of 10-15 per cent. gum arabic, 25-30 per cent waterglass and 10-15 per cent caustic sodium. The material is then burned to carbon and prepared in carbo-hydrates. That carbide of silicon possesses good properties for electric resistant bodies is demonstrated by the German patent of Bross. Siemens. based on Dr. Eggly's work. An application of the same firm for the manufacture of these filaments as a supplement to the previous patent[74] proposes also the addition of conductors of the second class (for instance, magnesia) or of the first class (for instance, tungsten or tantalum). A similar flux method for the preparation of electric heating and glowing bodies conducting when cold emanates from Oscar Froehlich[75] and the late Elektrodon-Bogenlicht Gesellschaft.[76] The conductivity of the arc-light electrodes at ordinary temperatures is accomplished by the addition of metallic iron. Startling as the results of this addition was at first, the disappointment of the inventors was great when the iron vaporized and the electrodes proved useless.

This fiasco led to the dissolution of the society for arc-light (Bogenlicht Gesellschaft). This reminds me of the first exhibition of the electrodon-zircon lamps (incandescent) on which the firm Siemens & Halske spent 60,000 marks, the only pecuniary success of the Electrodon-Gesellschaft. The General Electric Co. protected the almost identical mixture (Fe, Mn, Ni, Co, Co_2, Zn, Ti, etc.), but the process is not continued further than to sintering process.

Platinum Metals do not form any carbides in the electric incandescent filament. Geminiano Zanni[78] deposited on a carbon core platinum or iridium electrolytically.

Aluminium Carbide. — Wilh. Buchner[79] surrounds a carbon core with oxides and silicates of Al, Ca, Zr, Beek, while Theodore Mace[80] prepares the entire glowing body out of a mixture of carbon, aluminium and nickel salts. John Michel Canello[81] impregnated cotton threads with rare earths with the addition of aluminium salts, after James Clegg[82] discovered that some metals unsuitable for glowing bodies give good results when mixed with aluminium.

Magnesium Carbide cannot be formed into filaments, as magnesia melted in carbon crucibles and held in molten state will not be reduced. At the melting point of magnesia the carbide cannot exist.[83] This way the action of the magnesium salts in the filaments, especially its high emissive power, has to be ascribed to the properties of magnesium oxide. It is therefore not clear high. W. L. Voelker will create magnesium carbide in his filaments.[84] Maximilian Baum[85] impregnated vegetable fiber with a solution of calcium chloride or magnesium chloride and then with ammonium phosphate, so that non-volatile phosphates of Ca and Mg are formed. It is claimed that the volatilization of ammonium chloride makes the phosphate incrustation especially porous and that the light emissivity is thereby increased.

Carbides of Alkaline Earths.—These carbides are easily formed at the temperature of the glowing filament, so that all proposals to surround carbon filaments with a shell of alkaline earths or incorporate them into carbon may be reduced to a proposal to use their carbides.

Berillium Carbid is claimed to be contained in Voelkel's filament,[87] while W. Buchner[88] provides only the filament of carbon with a cover of the oxides or silicates of Ca, Al, Zr, Be, etc.

Phosphates. — Additions of ammonium phosphate as ingredients of a second bath for the impregnation of filaments was frequently recommended with a view of transforming the salts of alkaline earths, of the rare earths, of magnesium and such like in durable phosphates.[89] Herramshoff proved that the rare earths form phosphates that are not decomposed easily at high temperatures and recommended them as coloring material for hard porcelain.[90] Moisson proved[91] that the phosphates of

alkaline earths, of iron, nickel, cobalt, chromium and copper are being reduced in the electric furnace in the presence of carbon to phosphites. It must be concluded that the same reactions are going on in the electrically glowing carbon filaments when phosphates are present.

General Considerations.—The high light-emissive power of the alkaline earths and magnesia was known long ago, before the arc light was practically introduced in the arts. Their application in arc lighting was then naturally suggested. Some attempts in that direction were not without some success. The candle of Jablochkof (1876), the sun-lamp of Clerk and Bureau (1880) lend some significance to these early attempts, although they were superseded by the further progress in the art of illumination. The endeavor to meet the competition of gas-light illumination gave the impetus to the successful application of the rare earths in the mantle. The improved glowing bodies proposed consisted of a conglomeration of a conductor of the first class with one or two conductors of the second class. At the start oxides or salts were mixed with a carbon powder and an organic binder (gum arabic, anthracite tar, cane sugar solution, etc.) to a paste and then squirted into filaments. The latter were then imbedded in powdered carbon and then subjected to glowing. Vegetable fibers or collodium filaments were impregnated likewise with corresponding salt solutions[92] or carbon filaments were used as a core and surrounded by layers of light-emitting earths (oxides, conductors of the second class)[93] or metals, also conductors of the first class.[94] Likewise it was attempted to make metallic cores.[95] The high point of fusibility of the metals of the platinum group lead of course to their selection. However, filaments of the brittle osmium, possessing a high fusible point, furnished great technical difficulties in their manufacture, till Auer perfected his osmium resp. osram lamp, and furnished a means for combating gas light illumination.

All proposals combining conductors of the first and second class for the purpose of manufacturing glowing bodies, as known, were without success in practical illumination. The reason for it is the influence of the high temperature of the glowing filament on the chemical combinations in its body. The formation of carbides undoubtedly leads to gas formation, which in their turn play a conspicuous part in the destruction of the filaments. In this instance even the recommendation of the German patent 128925[96] must be of no avail, as it is demonstrated that it is impossible according to present experience to prepare filaments out of the metal zirconium or its oxide without an organic binder. This also applies to the German patent 138468[97] of Kellner, according to which glowing bodies are prepared out of a combination of thorium or titanium with an admixture of their oxides. It is likewise to be taken into consideration that in bodies combining the conductors of the first and second classes in which the core is being composed of carbon the mantle of oxides represents a surface surpassing in dimensions five or six times that of the core. In order to generate the heat requisite for the glowing of the mantle through the latter a current must be forced that is intense enough to volatilize it.[98] The inverted method was also suggested, namely, the formation of a core of conductors of the second class encased in a layer of a conductor of the first class—a metal. Such a proposition we met already in the classical patent of Jablochkoff (German patent 1630 of August 14, 1877) and in an English patent (13883-99) (1886). Even in manufacturing so-called Nernst glowers conducting the electric current at ordinary temperatures out of a mixture of two or several oxides instead of a magnesia or zircon-earth (with yttrium oxide, for instance), the awkward preliminary heating is yet unavoidable. Scharf[100] wanted to avoid this drawback by conglomerating metals with oxides, an idea we will come across again in the German patent 128925.[101] The suggestion consisted in the use of metallic zirconium with the oxide of zirconium (ZrO_2). Considering all oxides as conductors of the second class, we must acknowledge the superior correctness of Bolton's idea expressed in the German patent 161081,[102] in which he suggests the combination of the lower oxide of tantalum having comparatively high conductivity with non-conducting oxide of zirconium (ZrO_2) into a filament and the subsequent reduction in the electric current of the oxide of tantalum into metal, while the unchanged oxide of zirconium remains in a finely distributed state. Just this fact is of the greatest importance for the manufacture of glowing bodies of a mixture of conductors of the first and second class. It was mainly demonstrated that the raw materials must be in the state of the finest division, only imperfectly attainable with purely mechanical means. It is, as known,

almost impossible to mix intimately the more or less ductile metals with oxides. Although Bolton's idea was quite correct, the affinity of the metal tantalum to hydrogen[103] prevented the practical application of the German patent 161081 for the manufacture of filaments. Tungsten does not have this inconvenient property. Hence it is possible to conveniently mix easily reducible tungsten compounds with conductors of the second class in hydrogen till the tungsten is reduced to metallic state.[104] This way a very intimate and fine distribution is attained in the conglomeration of the conductors of the first and second class.

According to a supplementary patent[105] molecular proportions of ThO_2 and ZrO_2 and tungstic acid are being fluxed in an iridium crucible with the aid of an oxy-hydrogen flame. The very durable tungstates are then pulverized. Heating the latter in hydrogen, a combination of conductors of the first and second classes is attained in finest subdivision. If one would succeed to produce a Nernst filament composed of a mixture of metal and metallic oxides in finest subdivision, it could be said that the filament contained in the glowing and heating bodies united in one. That the tendency is recently in that direction can be concluded from the German patent 187083,[106] according to which a conductor of the first class—tungsten metal or its alloy—is mixed with a conductor of the second class in the shape of rare earths (ZrO_2 and yttrium-earth). As I see no way for the present to avoid organic binders, and the rare earths easily form carbides, I suspect in these filaments also the presence of carbides. It is to be noted also that Léon de Somzée in 1899 formed in Brussels[107] a glowing body of the metal silicon with small admixtures of rare earths in order to increase their light emissivity.

The advantages derived from the addition of the salts of alkaline earths, rare earths, magnesium and so forth to arc-light carbons is known for a number of years. Experiments conducted by various parties and the patent literature proves that the best results are attainable with the aid of calcium salts, that beryls, aluminium and magnesium salts are less luminous, while strontium salts impart a too red color to the flame of the arc. Fluorspar, that turned into common property long ago, gives a reddish-yellow (orange) color. The red is intensified when the current drops down or the carbon of a considerable diameter. Fluxes are used for the, for instance, silicates or borates[108] in order to counteract the tendency of the mineralized carbons to slag. Carbides must be formed as intermediary products in mineralized carbons as the high temperatures of the arc and the carbides are subsequently dissociated and turned into oxides. It is proven that the vapors of alkaline earths and rare earths are very good conductors of electricity, the quiet burning of the arc being dependent not only on the molecular ratio of the mixtures, but of the shape of the core and various other circumstances.[109] H. I. Keyser[110] avoids the obnoxious formation of slags by making arc-light electrodes directly from carbides, for instance, carbides of the alkaline earths, and protecting them against the injurious influences of atmospheric moisture by a shell or tube of metallic copper.

Fr. J. Gerard and L. Fiedler express a peculiar theoretical view in their German patent 185291,[111] namely, that an oxygen compound of lanthanum with thorium or zirconium may form luminous gases in the arc. It is claimed that three times more light may be this way generated than with ordinary carbon. The peculiar features of this theory is that the new oxygen compound, vividly reminding Vyrouboff's theory of complex oxides,[112] is prepared by glowing the double nitrate of lanthanum with thorium or zirconium. The formulas for this combination are even given as $La_2 (NO_3)_6$, $Th (NO_3)_4 + 12H_2O$, $La_2 (NO_3)_6$, $Zr (NO_3)_4 + 5H_2O$. It is claimed that superoxides $(La\ Th)\ O_3$, resp. $(La\ Zr)\ O_3$ are formed in the arc and color it intensely. We may lend credence to the assertion of the inventors that the arc produced by their miraculous carbons is only 1.5 mm. long, while the arc of ordinary carbons is 3-6 mm. long. However, the doubtfulness of their theoretical expostulations must be apparent to the inventors themselves. An application for a patent is not a scientific publication, and yet the examiner of the patent office ought to demand proofs of the correctness of the given chemical compounds. Many an alleged inventor imparts to his application a scientific tinge by advancing the most wonderful theories with the intention to get around another patent. This is the reason why we find the identical material patented over and over again, and there is little to be wondered at the patent literature of England and France.

I cannot conclude this essay without mentioning the newest application for a holder for filaments composed of carbides indecomposable by water (B, Si, Cr, W, Cho, T, etc.) *(To be continued.)*

Miscellaneous News

VENICE, CAL.—George B. Brookings, a St. Louis millionaire, has left for the East to place before other capitalists in the Missouri city, with whom he is associated, plans for the establishment in Venice of a big factory for the manufacture of incandescent globes, with a patent mechanical pump, which, according to tests of the machine made here produces a perfect vacuum necessary for the globes.

The pump, to which Brookings has patent rights, will, he declares, produce a vacuum in which the incandescent light will burn for an average of 2,000 hours, while the average life of the lamps produced for commercial use now is less than 1,000 hours. Brookings also declares that the lights his pump produces will cost less than one-half the present price. Climatic conditions in Southern California he regards as the best in the country for the operation of such a plant as he proposes to establish. When completed it will cost something over $50,000 and give employment to fifty skilled workmen.

KANSAS CITY, MO.—A plan for a uniform system of downtown street lights is to be formulated by a committee representing retail merchants in the Business Men's League rooms. The committee is composed of eight members of the League and about twenty-five business men. John W. Wagner is the chairman.

SYRACUSE, N. Y. — The Syracuse Lighting Company is planning to substitute for the present open arc street lamps, lamps of the "magnetite" type. The lamp meets the specifications for street lamps contained in the Hammond act and is a more desirable lamp than the type with which the city street lighting system is now equipped. The specifications for arc lamps contained in the Hammond act follow:

"Each electric arc lamp used for street lighting purposes within the city after the expiration of one year from the taking effect of this act, shall furnish a volume of illumination at least equal to the so-called 2,000 candle-power nominal series direct constant current open arc lamp, using not less than nine and six-tenths amperes of current and burning at from forty-five to forty-eight volts at the arc with one-half inch solid copper coated carbon."

Mr. Blakeslee says in commenting upon the specifications:

"This evidently limits the street lighting unit which may be used in this city to one which shall equal these specifications. These specifications need an interpretation, for it is well known that even the lamp referred to will not furnish the illumination called for if they are interpreted literally, if only from the consideration that the lamp has to feed. Furthermore, as no mention is made as to whether maximum, normal or average illumination is meant this point must also be determined. It would seem that the intention of the specifications of the Hammond bill was to secure for the maximum price fixed, a lamp which would give a street lighting service as good as the one upon which the price was based. It is evident that the intention of the law is to cover practical, rather than theoretical, operation. Under this interpretation of the law would say: 'A volume of illumination which taking into consideration all its essential characteristics is equal to the volume of illumination furnished by the so-called 2,000 candle-power nominal series direct current constant current open arc lamp using not less than nine and six-tenth amperes in current burning at from forty-five to forty-eight volts at the arc with one-half inch solid copper coated carbon in practical operation.' My opinion of the comparative equality of two lamps under consideration contained in this report is based upon this interpretation."

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Special Notice.

Beginning with March, 1908, the subscription price of The Illuminating Engineer will be $2.00 a year. See announcement on inside front cover.

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Public Lighting and Public Spirit

Street lighting became a generally recognized public utility with the introduction of illuminating gas; the electric light demonstrated the possibility of so lighting streets that they become objects of general attractiveness,—an expression of the public spirit of the city.

It is no mere figure of speech ta say that a city is known by its lights. Dark streets are invariably empty streets at night, and the stranger flees the unlighted town.

New York, the Metropolis of the western hemisphere, has many attractions for the stranger within her gates. There are parks of every description; theaters and opera houses innumerable; museums and public libraries; churches and cathedrals; but of all these numerous attractions, which one is best known to the average American? The "Great White Way," that stretch of Broadway, about a mile in length, from 23rd to 46th streets. Here are displayed a greater number of lights, more expensive and elaborate illuminated signs, and a more dazzling brilliancy than in any other thoroughfare in the world.. Consider for a moment what it would mean to property owners in this section if all these lights were extinguished!

What this spectacular lighting does for Broadway, it will do to a proportionate extent for the principal business street in YOUR town. As a mere matter of municipal investment there is nothing that will bring such sure returns as the attractive,—yes spectacular, if you please,—lighting of the business streets of a city.

Lighting of this kind reflects credit upon, and gives prestige to the entire city, and is therefore a work in which all should be interested. By giving assistance in the way of favorable rates and engineering skill, the lighting companies can show that they have the general welfare of the town in view. By a liberal use of spectacular lighting the merchants can give a general air of prosperity to the town, which will be reflected in increased trade. The citizen can, and will, show his appreciation of this public spirit by giving his patronage to his home merchants instead of taking it to other cities.

Public enterprise is contagious. A single block, or even a single building brilliantly lighted and outlined is sure to spread to adjacent blocks.

There is but one city that does not need illuminating, and that is the city of the dead—the graveyard.

LIGHT UP, AND KEEP LIGHTED UP!

E. L. Elliott.

THE ILLUMINATING ENGINEER

Vol. II. FEBRUARY, 1908 No. 12.

Spectacular Lighting in the Past

If anyone imagines that spectacular lighting on a large scale is a recent invention, made possible by the electric light, he will find himself entirely mistaken if he will take the trouble to look up the history of the subject. What we term "spectacular lighting," *i. e.*, outdoor illumination designed to impress the beholder with its beauty or novelty, rather than to serve the mere purpose of lighting streets or public places, is as old as history, and probably took place in prehistoric times. Fire worship is an evidence of the natural fascination which artificial light has for the human mind; and the fact that flames produced for the sake of their light have been used from the remotest antiquity to the present time in the rites of every great religion shows how this fascination of the primitive mind by light has persisted. The use of fire was an essential element of the ancient Jewish sacrificial rites. In the Saturnalian rites in Rome in an equally remote period, the sacrifices took place at night. The Emperor Adrian made a public bonfire in Rome of the evidences of indebtedness—corresponding to our bonds of the present time—of the provinces, amounting to nearly $7,000,000, an enormous sum at that time. The event was commemorated by the striking of medals.

These public illuminations, however, were not confined to bonfires. On the occasion of the birth of princes, or special religious solemnities, the inhabitants hung little oil lamps in all the windows of their dwellings. The religious festivities known as the "Quinquartries," given in honor of Minerva, consisted essentally in a general public illumination. The most remarkable and expensive piece of spectacular lighting of all history was that produced by Nero when he had the whole city of Rome set on fire.

Spectacular lighting also received marked attention in France at a later period. In the reign of Louis XIII such illumination was carried out with great enthusiasm. The inhabitants of Paris vied with one another in adding to the general display. The *grand seigneurs* decorated the fronts of their mansions with bronze candelabra in which enormous wax candles were lighted at night. The common people

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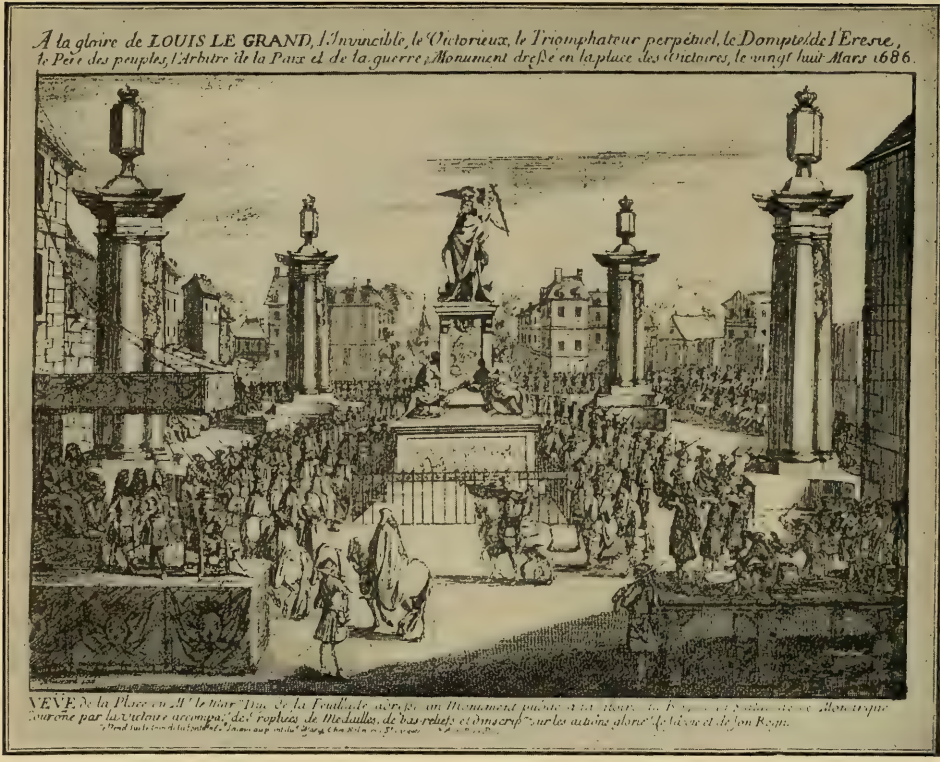
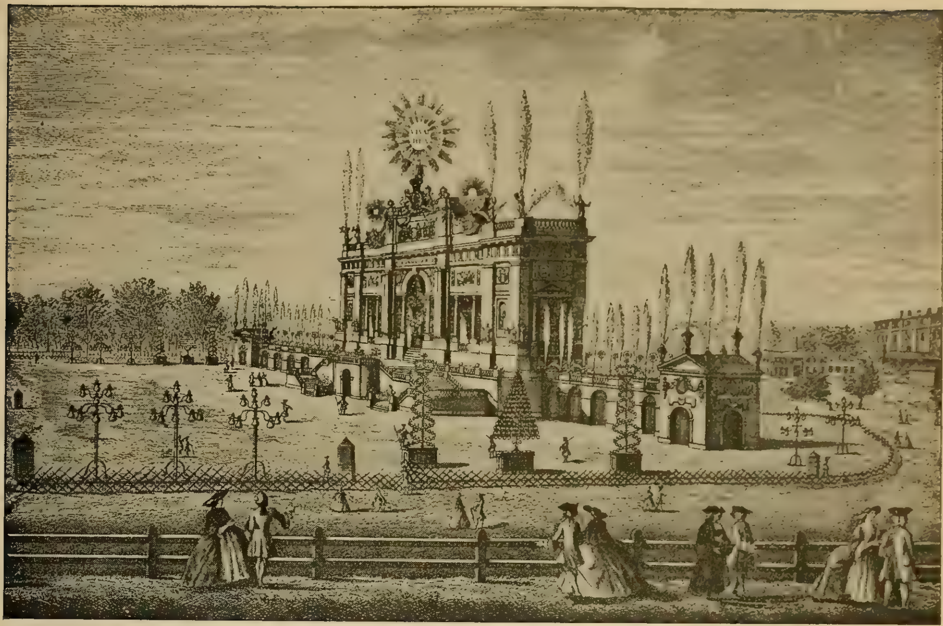


PUBLIC ILLUMINATIONS IN THE SEVENTEENTH CENTURY.

To the Glory of Louis the Great, the Invincible, the Victorious, the Perpetually Triumphant, Subjugator of Ersie, the Father of his People, the Arbiter of Peace and War; monument erected in the Place des Victoria, March 28, 1686.

View in the Place, where Marshall the Duke of Feuillade erected a public memorial to the glory of the King, with a statue of the monarch crowned by Victory, accompanied by trophies and medallions in bas relief, setting forth the glorious deeds and services of his reign.

also took part in these demonstrations, the merchants and artisans hanging brilliant colored paper lanterns in their windows. These public illuminations continued into the eighteenth century, at which time the process of making fireworks had developed to a very considerable extent. What we know to-day as "outline lighting" was even at that time practiced, although the only available light-source was the oil lamp similar to the Roman lamp, or a simple earthen ware dish with a wick for burning fat, such as were sometimes used by our grandmothers, and called "grease lights." These little lamps were hung in a symmetrical way so as to mark out the windows and other architectural lines of buildings. When public enthusiasm for this sort of demonstration could no longer be depended upon to insure sufficiently magnificent results the matter was taken in hand by the government. The *Mercure,* of January, 1752, thus describes the illumination of the fète given by M. Julien, Consul of France at Nice, on the occasion of the birth of the Duke of Burgundy. "On this occasion, the mansion of the consul



PROPOSED SCHEME FOR SPECTACULAR LIGHTING FROM AN OLD ENGLISH PRINT.

Judged by the proportionate size of the spectators, it was certainly of magnificent proportions, and, if carried out with gas flames of the size indicated, would furnish a spectacle comparable with the most striking instances of modern spectacular lighting. There is no information as to whether the scheme was ever actually carried out. It, however, is suggestive of the possibilities of flames for such illumination.

was illuminated by enormous wax torches. The arms of the king appeared in the middle of the façade, with the arms of the Dauphin and the Duke of Burgundy on either side.

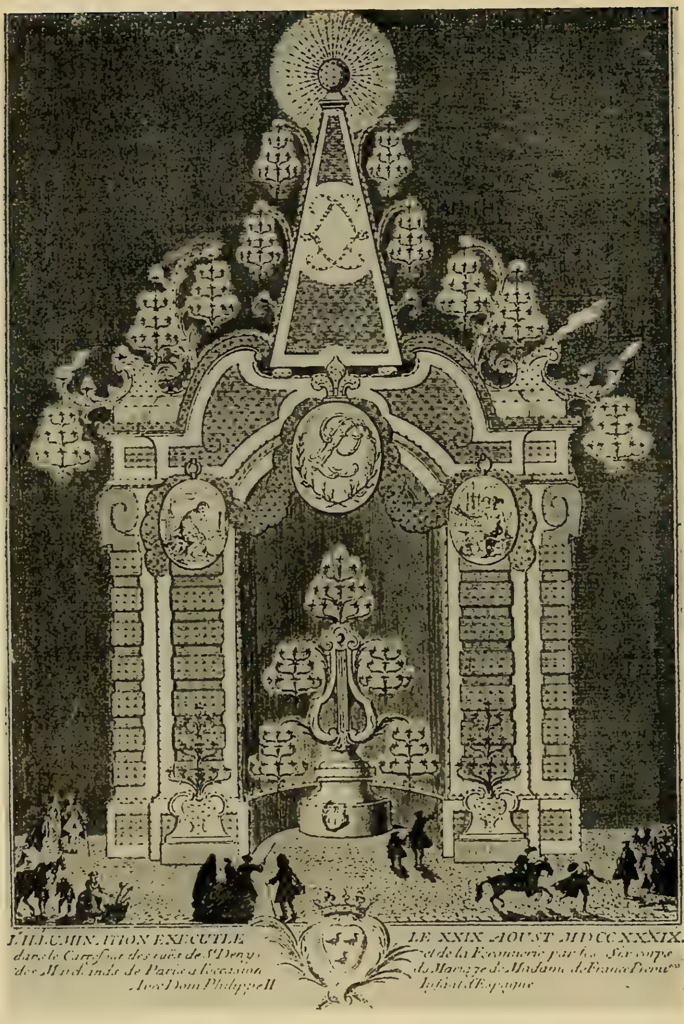
The edict issued covering one of these occasions runs as follows:

"It is ordered and notice is hereby given that it is required by the Procurator of the king and of the city in execution of the orders of the king, and a decree of the court that all inhabitants and householders of this city illuminate the torches of their dwellings on Sunday next, the seventh of the present month, when his Majesty has ordered that the *Te Deum* be sung in the metropolitan church of this city as an act of thanksgiving for the conclusion of peace. Local officers, the constable and court criers and commissioners of the town are directed to execute these orders, which will be read, published and posted wherever necessary, and will be executed against all opposition or appeal whatsoever, without prejudce."

These public illuminations afforded a means of existence to a considerable number of tradesmen and manufacturers, and the candle merchants of Paris were given special charge of this class of work. The following notice may, in a way, be considered the prototype of the modern advertisement of a central station:

"Berthelin, Saint Honore Street, near St. Honore, Chandler-in-ordinary of the city, undertakes illuminations and decorations for public and private festivities."

In 1764 an inventor by the name of



An illumination executed the 29th of August, 1739 at the intersection of Rue St. Denys and Feronnerie, by the six corps of merchants of Paris, on the occasion of the marriage of Madame De France I. to Don Phillippe II., Prince of Spain. From an original engraving by Sloditz.

The light-sources are evidently oil lamps. According to the proportions which the engraver has shown the structure would be as tall as a modern sky-scraper. The actual dimensions can be better judged undoubtedly by considering that the oil lamp of those days was a very trifling affair; and by this comparison the illumination shown would make little impression beside modern instances for similar purposes.

Renault devised a scheme of using a fuse of guncotton running from one lamp to another, by which it is said that 2,000 of the oil lamps could be lighted in less than five minutes. M. Renault presented his process to the Academy of Science, which awarded him honorable mention.

ERRATA.

Page 851—2nd column—10th line, amount $200,000 should read $300.00.

Page 854—1st column—19th line should read Figure 6 instead of Figure 5.

The Development of Motion Effects in Electrical Signs

By J. A. Goldberg.

Not the least important among the revolutions which the electric lamp, has wrought in the general field of illumination, is the use of illuminated advertisements, or signs. Country fences, barns, and even available spaces of natural scenery have been the receptacles of advertisements for many years, and from this practice undoubtedly was developed the modern billboard, which as an advertising medium has grown to vast proportions.

But the great weaknesses of all such signs is their complete uselessness at night. While this matters little in rural districts, it is a question of the utmost importance in cities. During the daytime the majority of the pedestrians in city streets are intent upon their business affairs, and therefore, so far as signs and billboard announcements go, may be classed among those who are traditionally the blindest of the blind—those they will not see. Besides, in the all-pervading light of day it is impossible to bring out such a sign in vivid distinction from the innumerable other objects which are equally attractive to the eye. At night these two conditions are reversed; the majority of the people in the streets are mind free, and in fact are usually out "to see what is to be seen," and against the black background of night it is a simple matter to make a sign stand out with such aggressive conspicuousness that he who runs not only may, but must read.

That this logic is sound both as to premises and conclusions is amply proven by the enormous investment of money represented by the modern electric sign. This is exemplified to a greater extent along the "Great White Way" in New York City than anywhere else in the world. In this stretch of some 23 blocks of Broadway, it is estimated that the value of the electric signs alone exceed $100,000, and that the nightly cost of operating them is not less than $200,000. The business houses represented in these advertisements are among the most successful concerns and shrewdest advertisers in the country, and it is perfectly safe to assume that they are not investing their money in this kind of advertising simply to

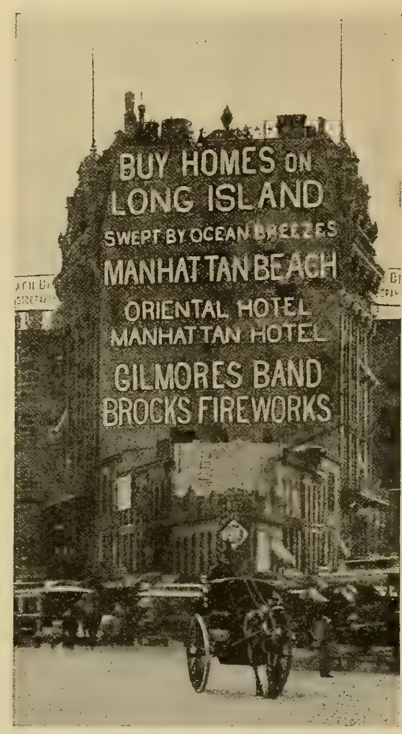


FIG. 1.—FIRST ELECTRIC SIGN IN NEW YORK.

amuse the nightly crowds on Broadway. Another equally convincing proof of the value of this kind of advertising is the fact that these signs have continually increased in size, complexity of construction, beauty of effect, and ingenuity in the methods used to attract attention. There is a constant competition to see who can lead in this marvelous panorama of luminous intelligence.

It may be interesting to recall the first electric sign erected in New York City. This was on top of a building occupying the site on which the world-famed Flatiron Building now stands, and is shown in Figure 1. This is the southern terminus of the Great White Way, and this sign was its forerunner. From that time forward the now familiar "electric sign," consisting of letters outlined with electric lamps, steadily increased in use and in dimensions. But no matter on what proportions such a sign may be constructed, it lacks one of the most essential elements of attractiveness—that is, lack of motion. That which is fixed and immovable soon becomes so familiar as to pass unnoticed. This first variations of this monotonous and dead effect was the simple device of "flashing" the sign; that is, extinguishing and relighting it at regular intervals. For purely advertising purposes this undoubtedly is preferable to the sign maintained constantly lighted.

The next step was the production of a sign which could be made to change the letters, and so spell out different words in the same position. This device was both startling and puzzling at first sight, and as a single stroke of ingenuity has never been surpassed. It was first publicly exhibited at the Pan-American Exposition, where it attracted great attention. It is known as the Mason Monogram, or more commonly the "talking sign." The space occupied by each letter is so divided up by an arrangement of electric lamps set in trough-shaped compartments painted white, that any letter of the alphabet, or numeral, can be outlined by lighting up a certain arrangement of the lamps, each lamp being wired separately. By the use of a necessarily rather complicated "commutator," or

FIG. 2.—"TALKING SIGN" SHOWING WORD "PHOTOSCOPE."

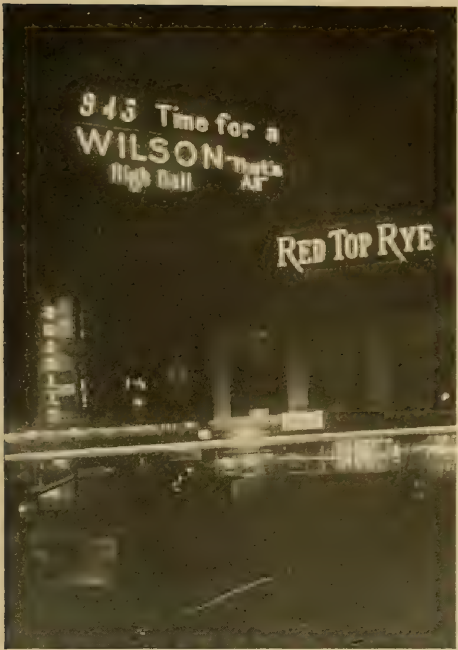


FIG. 3.—SIGN TELLING THE TIME.

switching mechanism, operated by a small electric motor, any letter in the alphabet can be produced, in any space, and thus produce any combination of words that can be made from the number of spaces provided. The first sign of this kind on the White Way was at No. 1369 Broadway. Figure 2 shows the sign as it is spelling out the word "Photoscope." It will be observed that there is one space dark at the left of the sign. The sign can, therefore, be made to show any word or phrase of eleven letters or less. Perhaps the largest sign of this kind now in use, is that on the Hamburg-American Line piers in Hoboken. One of the remarkable features of this sign is, that while it is located in the State of New Jersey, it talks to the people of New York, for it is plainly visible across the river, and is intended especially for the benefit of the thousands of people who pass nightly on the numerous ferries.

The next step in the development of motion effects was the sign which told the time to the minute in figures, a view of which is shown in Figure 3. This shows that the photographer was "on the job" at 43 minutes past nine. The next minute the sign would change to 9.44; and so on each successive minute. Whether or not the photographer heeded the advice given in the legend, we have no record. The sign was conspicuously displayed in full view of the corner of 42nd street and Broadway, which is now the center of the theatrical district.

Probably the most persistent users of electric signs are theaters, whose business is almost exclusively nocturnal. Figure 4 shows a different form of motion effect from that used in the preceding example. In this case the wheels of the wind mill revolved slowly. The lamps on the wind mill were red, as were also those outlining the mill, with the exception of the door, which was green. The other lamps were white.

The next step in the evolution was the sign erected on the Herald Square Theater. The circle in the lower left hand corner is outlined in red and green, the lettering within in white. In operation, a stroke of lightning is imitated by a motion effect from the outer extremities of the zig-zag lines to the circle at their point. Immediately following this the words within the circle appeared, while the ring around the circle was made to revolve by the usual method, and the balance of the lettering then appeared.

Following this came the Victor Phonograph sign, in which was introduced a new use of motion effects. The sign, as can be judged by comparison with the building, is of large

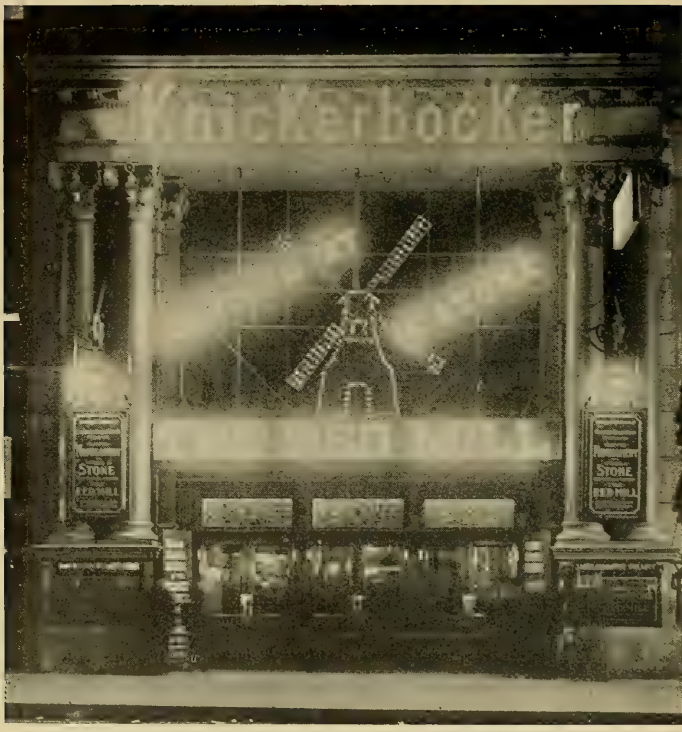


FIG. 4.—SIGN WITH MECHANICAL MOTION.

dimensions, showing a trade-mark which has become a household word in America. The disc of the phonograph was outlined with incandescents, which were lighted and extinguished in succession in such a manner as to give the disc the appearance of turning around, which added enormously both to the beauty and attractiveness of the display. Beside the motion effect the use of color also added to its artistic appearance. Above the word "Victor" there was a line of red lamps, which naturally do not show in the photograph. The collar of the dog was in red. The lamps used were the 8-c.p. size.

The increase in size and complexity is well shown in Figure 5, where the dimensions of the sign can be judged in comparison with the building. The flow of water from the siphon was simulated in the most fascinating and beautiful manner by a row of small

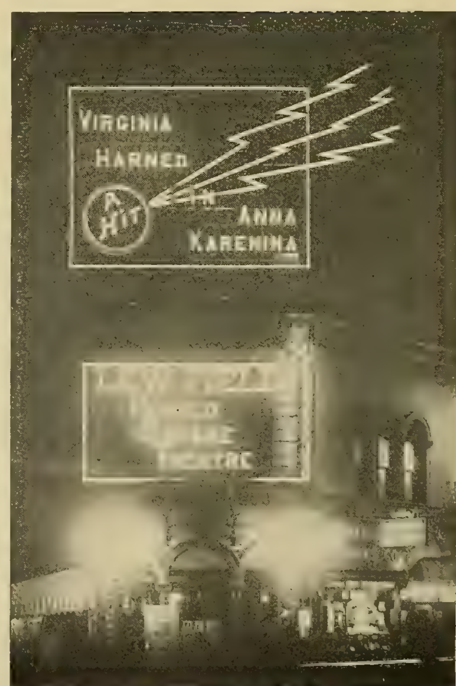


FIG. 5.—SIGN WITH SIMULATED MOTION EFFECT.

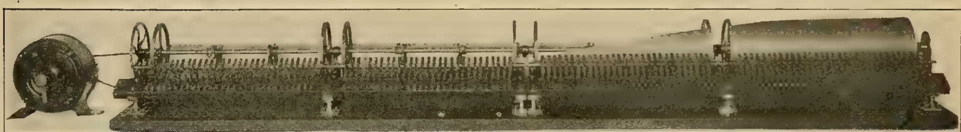
FIG. 6.—MAKING A "GIN RICKEY."

FIG. 7.—PHOTOGRAPH IN MOTION.

incandescents which were successively lighted and extinguished.

Upper New York, which still popularly retains its ancient name of Harlem, has its own Great White Way, comprising 125th street between Third and Eighth avenues. Within this portion the illumination will compare favorably with that of the down-town section. The sign shown in Figure 8 is sufficient evidence of the popularity of this thoroughfare by night. The letters and numerals are white, outlined in pale pink. The spot is a mixture of blue and purple lamps which represent a stain. In the operation of the sign the spot first appears, then the balance of the sign, and the liquid drops from the bottle, the motion being represented in the usual manner by successive lighting and extinguishing. In a few seconds the spot disappears, and in its place the figure "23" is shown in red, with a white lamp in the center to indicate that the stain is gone.

Two recent theater signs are shown in Figures 9 and 10. In these both color and motion are utilized. The color scheme of the Casino sign is as follows: Star, white, with red center, and red rays; zig-zag border, blue on left, red on right; outline, red; letters,



SWITCH MECHANISM FOR MOTION EFFECT.

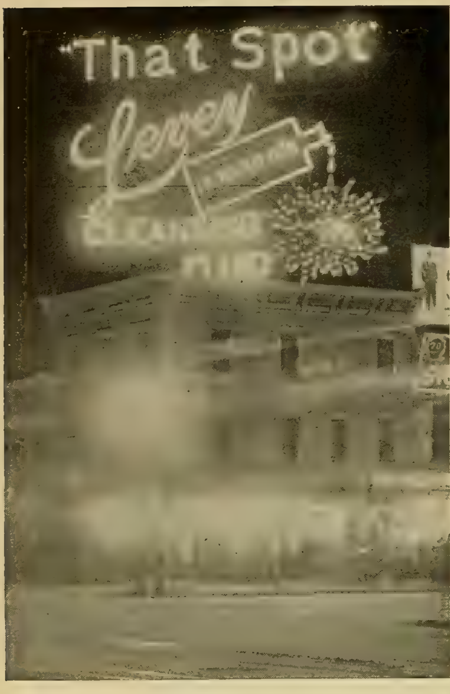


FIG. 8.—OUT, DAMNED SPOT!"

white. The sequence of "flashes" is as follows: (1) Star appears, (2) center, (3) rays, (4) zig-zag, (5) words in lower panel, (6) all out, (7) all on together.

The color scheme of the Knickerbocker is as follows: Words "Knickerbocker" and "The Talk of New York," white; words in circle, green; outline of horse, red; rider and fence, amber. The horse rocks on a pivot, and the lamps outlining the fence simulate motion, thus giving the effect of a horse running.

There is something peculiarly fascinating about anything in motion, particularly if the cause of the motion is not apparent. The effect of motion as a feature of advertising signs is, therefore, well worth the labor and expense necessary in their production. But in this as in other cases, a frequent change of "copy" is necessary.

FIG. 9.—COMBINED COLOR AND "FLASHES."

FIG. 10.—HORSE RACE.

Spectacular Lighting

By Raymond T. Vredenburgh.

Spectacular illumination has played a large part in the world's affairs ever since the creation. People as well as animals are attracted by light.

The Roman Emperor Nero created some spectacular effects that have probably never been equaled. The burning of the city of Rome was his best, and has only been approached in pyrotechnics by Pain.

The Roman Flambeaux served its purpose as effectually as the incandescent lamp does to-day; but all artificial illuminants are outclassed by nature with its Aurora Borealis and marvelous volcanoes.

Spectacular illumination has its religious significance in the Catholic Cathedral with its many candles and wonderfully designed fixtures.

The unique position held by fireworks must not be overlooked; no patriotic celebration is complete without them; and thousands of people are attracted to places of amusement, when the Last Days of Pompeii, and similar spectacles are graphically depicted by this means.

A great deal of money is spent every year for spectacular illumination as used in the festival Mardi Gras at New Orleans, and the Procession of the Veiled Prophet in St. Louis. Until a few years ago the streets of the last-named city were arched with gas piping, and a burner placed every few inches; this was considered very wonderful and drew throngs from great distances.

The first real artistic illumination of any magnitude was displayed in the lighting of the World's Fair, held in Chicago in 1892 and 1893, the greater part of which was designed by Luther Stirenger, who afterwards designed the lighting for the Buffalo and Omaha Expositions. While not in charge of the illumination of the St. Louis Exposition, his failing health preventing, he had been retained in an advisory capacity and had made many valuable suggestions which were utimately carried out.

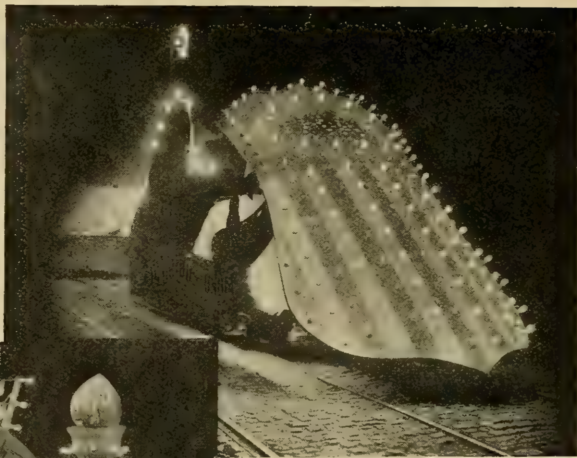
Luther Stirenger died a short time ago, and his loss is keenly felt by all who knew him. The collection of uncut gems was his hobby, and probably gave him many ideas for the artistic arrangement of colored lights. He was recognized in his day as the unrivaled authority on questions of decorative and effective illumination.

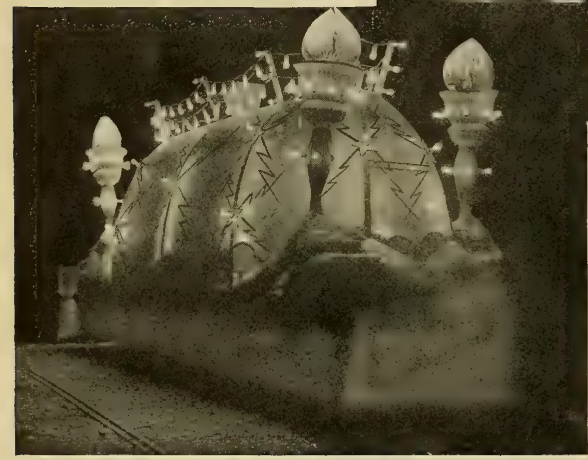
The illumination of Niagara Falls, by W. D'A. Ryan, of the General Electric Company, last year is an instance that stands by itself. When the idea of illuminating the Falls was first brought forward, a storm of sentimental disapproval arose on the score that such an act would be a desecration of nature. Mr. Ryan persevered, however, and the result is one that will live long in the memories of those who saw it. Thirty-one, thirty-inch projectors directed their intense candle-power on the Falls every evening for a month, and an infinite variety of effects was obtained by the use of colored celluloid discs placed in front of the projectors at different times. The total candle-power for this work was approximately 1,100,000,000.

Another instance of lighting that must be mentioned is the illumination of the city of Philadelphia during the Elks' Convention last summer; the entire city seemed to act as a unit in the elaborate electrical illu-

mination of all objects, buildings were outlined, new signs were erected, emblems placed in windows and even the clocks in front of jewelry stores were covered with small incandescent lamps.

Upon the return of a conquering hero a few years since, the imposing and majestic sight of the Navy of the United States brilliantly illuminated by electric light parading the Hudson River, was a spectacle that inspired patriotism in the breasts (all who saw it.





TROLLEY CARS CONVERTED INTO ILLUMINATED "FLOATS," USED IN GRAND ARMY PARADE IN BOSTON.

During the summer of 1906 the residents of the North Shore in Massachusetts were startled by seeing fantastically shaped jets of steam hurl themselves into the night, clothed with every imaginable color. This phenomena was accompanied by The Electric Steam Scintillator which was set up at Nahant.

This piece of apparatus consisted of a scintillator, a steam boiler and a number of projectors.

The scintillator consisted of nozzles and valves placed on the ends of steam pipes which were in turn attached to a wooden staging and covered with canvas so as to represent the side of a mountain.

Each nozzle was named as follows, the same being chosen from what it most suggested:

Niagara nozzle, fan nozzle, snake nozzle, plume nozzle, column nozzle, pin wheel nozzle, sunburst nozzle.

The Snake nozzle in particular, seemed endowed with life and consisted of a piece of garden hose connected with the steam pipe; the steam escaping through the flexible hose, caused it to swing around in a most grotesque manner.

Is it any wonder that the Committee on Spectacular Illumination for the Jamestown Exposition, immediately endorsed this electric scintillator?

Similar instances could be mentioned without number, but the limitations of space forbid.

Spectacular illumination has an-
self and has created a separate de-
other side which is of the utmost

importance, and that is the commercial value, in elaborate and novel electric signs.

Sign lighting occupies a field by itpartment in most of the central stations. The field for original design in the making of electric signs is unlimited, the most startling example may be seen on Broadway between 33rd and 44th streets, this portion of New York City being the center of the universe. It is justly said if one stands at the corner of 42nd street and Broadway long enough, he will be able to see every notable person in the civilized world.

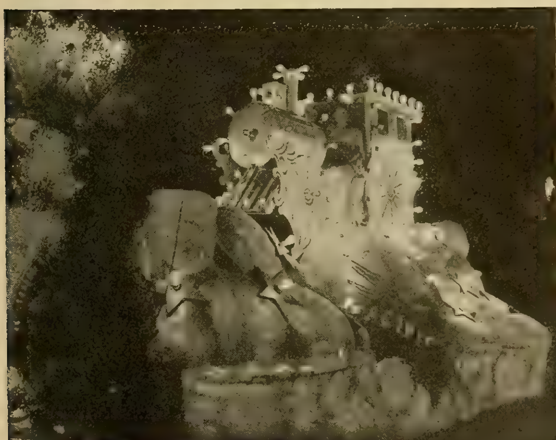
The modern hotels are giving a great deal of attention to spectacular yet artistic illumination, the Hotels Belmont, Astor and Plaza are the most striking examples and one is immediately impressed with the soft illumination pervading the halls and dining room where most of the units are hidden from view.

The commercial value of spectacular illumination is fully appreciated by the business world as is evidenced by the steady increase from year year of its use as an advertising medium.

A comparison of the appearance of the principal thoroughfares of any large city by night, with that of five years ago will abundantly substantiate this fact.

I venture to say that in the near future spectacular illumination will have created a new profession for the ambitious illuminating engineer.

The accompanying cuts in no way pertain to the foregoing article, but are hitherto unpublished photoraphs which have a bearing on the subject.



ELECTRICALLY LIGHTED "FLOATS" IN STREET PARADE.

Light and the Moving Picture Show

By H. Thurston Owens.

The great increase of moving picture theaters in our Metropolis has caused special investigation to be made by the Police Commissioner, Board of Fire Underwriters, the District Attorney and are probably worthy of the attention of illuminating engineers.

These miniature play-houses are so numerous in the larger cities that some special feature of outside illumination has been adopted by the more pretentious as a magnet to attract their patrons — the passing throng. "The World in Motion" has recently been opened on 14th street, New York City. It is opposite Tammany Hall, and owing to its size, cost, and lavish use of light, commands our attention.

A permanent theater seating over 650 people, which cost $25,000 to equip, exclusive of the building proper, lighted by means of 5,000 lamps, and an upright flashing sign equipped with 1,250 more lamps is unusual, it is impressive.

The main floor seats 514 people, and across the rear is a mezzanine balcony fitted with boxes seating 150 more.

The prices charged are 10 cents for the former, and 20 cents for the latter. It is a continuous performance and thousands are entertained daily.

"THE WORLD IN MOTION": THE LARGEST "AUTOMATIC VAUDEVILLE" IN AMERICA.

The sign shown in Figure 1, is 31 feet long, weighs a ton and at its highest point is 50 feet above the sidewalk; its cost was $2,000 installed. In order to secure it firmly, it was necessary to extend supports to the rear wall of the building. It has 1,250 4-cp. clear lamps, and 570 of them have amber colored glass caps. By using these caps, a uniform color is produced, and the life of the lamps is not impaired.

The words "World in" are raised letters 3 inches deep, painted white, the letters of "Motion" are only 2 inches deep, and are painted yellow, the result being that the sign is legible by day as well as night. The

flashing operation is performed by means of a combination of 5 flashers, making a cylinder 6 feet 6 inches long, and is so perfectly balanced that it almost runs away from a 1/20-h.p. motor. Its action is as follows: The words "World in" and the ball of the sun are illuminated for two or three seconds, and then "World in" are turned off, and "Motion" and the sun's rays come on. The border with 2 chasers at opposite points is moving continuously without regard to the lettered portion of the sign.

The interior is in red, brown and gold, and there are no lighting fixtures. The side walls have blind doorways arched with 8-c.p. frosted lamps over same, alternate lamps being on a separate circuit, so that in case of the main circuit burning out the room would still be lighted.

There is a row of 8-c.p. frosted lamps under balcony and around the border of the stage. The walls are slightly arched and at the edge of the curve lamps are imbedded, making a complete square around the ceiling. These are 4-c.p. frosted.

This is probably the largest amusement hall of its kind in the world, and is a shining example of the advertising value of light.

Spectacular Lighting in Connection with the Church

The use in connection with religious worship of the same methods and means that are used to openly advocate the use of intoxicating liquors doubtless appears of questionable propriety to many of the truly devout; but as Martin Luther could see no reason why the devil should have all the good music, and consequently did not hesitate to take the airs of drinking songs as a medium for impressing religious sentiment, so the prelate of to-day may by the same token utilize the electric sign in the furtherance of religion. In this case, however, history shows the reverse as to the original use of spectacular illumination, which had its origin in religious rites, and has always had a prominent place in the Christian church, particularly that old and large section of it commonly designated as Catholic.

If the theater, the salon, and the penny vaudeville may blaze forth their attractions in letters of light, why should the church remain in oblivious darkness? The regulation electric sign, giving the name of the church

MODERN ILLUMINATION APPLIED TO AN ANCIENT RITE.

CHURCH BY DAY.

IN HOC SIGNO VINCES.

and the hour of service, has been used in New England; and there is at least one example in New York City, in which the sacred emblem of Christianity is outlined in light; this is the cross on top of the church at the corner of 122d street and Mt. Morris avenue. Day and night views of this are shown in the illustrations.

An interesting illumination in connection with a religious celebration is shown below. This was erected on the street in the Italian quarter of New York during the celebration and must have been highly impressive, especially upon the class of spectators for whose view it was especially intended.

Spectacular Lighting in Philadelphia

Spectacular lighting in Philadelphia is best characterized by that trite expression, "Conspicuous by its absence." Philadelphia has its own manners and customs, and so long as these satisfy its citizens, surely no

FIG. I.—ILLUMINATED AWNING, WANAMAKER'S.

outsider has any particular license to kick. It seems, however, to the inhabitant of New York, or the denizen of the western town, that she is really missing a good deal in the way of public illumination. The display at the Elks Convention held some months ago, shows what she can do when she really sets about it; the pity is that this really magnificent exhibition did not leave more permanent results. There are many cases where just such special illuminations have so impressed the citizens as to leave a permanent impression in the way of outline or spectacular lighting.

Practically the only cases of lighting which may be called spectacular are those of the "penny arcades," one of which is shown on the opposite page; and to which, by the way, the merchants on Market street have rather vigorously protested, but more on account of the noisy nature of their mehtods of attracting attention than the display of lighting.

Figure 1 shows the illumination of the Chestnut street side of Wanamaker's store on the occasion mentioned. While this might be considered an elaborate display when compared with no lighting at all, it is far less elaborate than many installations in western cities that are used regularly, and would be by no means an exaggerated installation to use nightly, or at least weekly. This single example, if set forth persistently, would undoubtedly be followed by other installations of this nature, to the great enhancement of the brilliancy and attractiveness of the principal streets.

FIG. I.—SHOWING THE THREE TYPES OF GAS LAMPS.

Showing Window Display of Gas Light

In our last issue there was shown a type of show window of a store handling gas appliances, which is unfortunately only too common. The following illustrations, furnished by the courtesy of the Detroit Gas Light Company, demonstrate in the most telling manner how attractive the display of gas light and its accessories can be made. Two of these were holiday displays, and require little comment. Since gas lamps themselves are merchandise, it is of course not only legitimate but essential that they be hung in the windows; but observe that in both cases the gas arcs are at the side where they do not interfere with the general effect. Observe, also, that even as common a thing as a parcel tied up with a string is made so attractive in the display as to make a strong appeal to the observer to be taken to his home.

These window displays furnish ample evidence that those responsible for them are both progressive and aggressive in promoting the use of gas for illumination, a fact fully substantiated by the position which gas illumination holds in the city mentioned.

Figure 1 displays in a manner both attractive and impressive the three classes of gas lamp; namely: the gas arc, the inverted burner, and the upright burner; the latter being shown in connection with portables whose artistic shades add greatly to the attractiveness of the window dressing.

FIG. 2.— AN ENTICING HOLIDAY EXHIBIT.

FIG. 3.—AN IMPRESSIVE DEMONSTRATION OF GAS ILLUMINATION.

The Lights of Boston

By Rollin Lynde Hartt.

From the Boston Transcript.

That delightful Parisian æsthete, M. Camille Mauclair, has given a most charming little essay in *La Revue Bleue* on "La Décoration Lumineuse." Naturally, he confines his criticisms—enthusiastic in the main—to Paris. For it was the Automobile Salon, with its miraculous illumination of the Grand Palais, that called them forth. Yet they apply with singular aptness to Boston. Indeed, the one notable change that has come over our city during the last seven years is precisely this development of night-time splendor.

As if to emphasize the seven years past, there stood a multitude of people in Tremont street every evening during the Christmas season, gazing up at the electrical display, crude but splendid, that embellished the front of a great store. You could not behold that throng, with faces upturned and with the posture always of awed amazement, however childish, without being reminded of the throng that stood massed before the State House when the new century came in. It might be comparing a small and trivial matter with a great and solemn one, but the suggestion was there all the same. And as you looked back to that other evening, seven years ago, you recalled that then the incandescent diadem of the Bulfinch dome was the most dazzling nocturnal spectacle in Boston. It is still the most dignified, the most stately in its joyous golden glow. But it is no longer the most dazzling. The seven years have filled streets and squares with a perfect carnival of illumination. Boston at night is almost like New York at night. It is infinitely more showy than Paris at night, save when an automobile show or the visit of a foreign sovereign makes Paris resplendent.

It matters almost not at all what the lights mean. There were people who thought the illumination of the State House dome a sacrilege. The flaming crown was too gay, they said. What, then, do they say of gay lights that blazon across the sky itself the merits of commodities for sale? Mr. Howells, discerning that the electrical pageant in Broadway is but an advertisement of actresses, whiskey, and motor cars, sees in this the pathos of all shallowness—even a kind of blasphemy or lèse-beauté. Mauclair, beholding the blazing signs flung over Paris, says you might take them at first for quotations from the great poets; on closer inspection, they turn

out to be advertisements of liqueurs, tooth powders, or comestibles. This seems to him a violation of taste. So be it. The show is none the less gorgeous. After a little we cease to consider the meaning of the commercial Feast of Lights. The advertisements cease to advertise. What remains is not a proclamation of one-cent vaudeville "for man, woman and child," or a plea in behalf of the kind of beer that made "Billy the kaiser" famous, or anything material, whether frivolous or base or vulgar. Instead, what remains is beauty, radiant and fascinating. Thus does advertising become the lamp-lighter of a Ville-Lumière.

And as meaning matters not, so form matters not—essentially, at least. They say there is nothing in the world so ugly but intense light will make it beautiful. A fortiori, there is nothing in the world so ugly but it becomes beautiful when it is made to consist of intense light. A mere row of pillars of capitals, if wrought in stars of solar rather than stellar radiancy, makes the heart leap up. One suspects that the splendor is helped somewhat by the broken lines of the letters, relieving the stiffness and arid hardness of their Roman regularity; one is even prompted to ask whether gothic capitals would not be less offensive by day, if only by reason of their less inane outlines, than Roman ones; but I think that this modulation of harshness is an almost negligible factor in the general effect. What we want and what we get is a blaze—a "brutal" blaze as Camille Mauclair has it. It is barbaric—except that no barbarians ever conceived of the like. Neither did the most luxurious folk of the past. What was Louis XIV's illumination of the Galerie des Glaces? An affair of candles.

Even color matters little, primarily, though here there is room for betterment. In general the illumination shows only the golden glare of incandescent bulbs. Only here and there has a margin or tracery in ruby red varied the scheme. Only once, so far as I have noticed, has a softer hue been favored. In Washington street, opposite Boylston, you will see an illuminated lager beer advertisement in which a delicate, rosy buff—if I may so call it—has been employed with really lovely effect. The sign seems a huge, glowing blossom of light. It is so charming that you wish others would adopt less garish coloring. Indeed, you almost want to arrange color schemes for whole squares, whole streets.

However, the advertisers won't let you, for each aspires to outshine (literally if not æsthetically) his neighbors. But even this has its merits, though not by good intention. The old-fashioned transparencies, lugubrious by night and hideous by day, are now completely outclassed. They are wrens at the peacocks' fancy dress ball and they still wear their street dresses.

Meanwhile there begins to be promise of "la décoration lumineuse" as practised in Paris when a foreign potentate is the guest of that "capital of civilization." Here and there in Boston, the electrical illumination follows the lines of a building, just as in Paris the contours of the Institute, the Palais de Justice, the Louvre, and other superb monuments are spelled out in gleaming threads of fire. The exquisite cornice of a building in Boylston street is now outlined superbly with incandescent bulbs. In the same street another building has traced its windows in light; also its sky line. But the Paris sensation, the marvelous display at the Grand Palais on the occasion of the automobile show, is so amazing because electricity, instead of gas, is employed. Usually the illuminations on gala nights have been simply a maze of dancing gas jets. Here in Boston an establishment in West street has been showing us what we, too, could accomplish with gas.

It has this superiority over electricity. It moves. It trembles, flickers, is sensitive to the least breath of wind. It is fire itself, not an immobile semblance of fire. One may be a bit amused when M. Mauclair, raving ecstatically over the glories of the Grand Palais, is reminded of Miss Loie Fuller, "the last human creature who has invented anything in poetry," and "whose name will remain inseparable from the history of luminous decoration." If one were to apostrophize Loie Fuller at all, I think it would be as the tutelary divinity of flame and not of the glowing filament. And flame, when it outlines the majestic structures along the Seine and sets them quivering inverted in the water, has surely its lessons for American cities. While electricity itself is incomparably brighter, there remains a sort of hushed solemnity about its motionlessness. On the other hand, gas, blazing in countless dancing jets, excites a wild, barbaric joy, such as no incandescent orbs or lines or constellations can afford.

When one writes of the merits of the various sorts of light one cannot but comment upon that new and terrible innovation, the so-called "flaming" arc lamp. If the old arc light verged toward violet, this

verges toward orange, and with an intensity hitherto undreamed of. It hits the eye with an overwhelming impact. Some have even begged for blinders, smoked glasses or green goggles. It argues a vast prosperity for the oculists. At the same time it uproots brotherly love by making one's contemporaries a ghostly race when they walk beneath it. The preachers will have their hands full counteracting its influence, unless we agree to "make up" for our nocturnal walks abroad, just as players make up before subjecting themselves to the glare of the footlights.

Nevertheless the flaming arc light has virtues, both commercial and æsthetic. Commercially it serves as a ferocious and unmerciful advertiser, operating with an inhumanity worthy of the Standard Oil. Miss Tarbell alone is worthy to report its misbehavior in Scollay square. From time immemorial there has existed in Tremont row a modest but deserving dime museum. Within the last year or two the Theatre Comique (biograph and songs "wid pitchers") arose to contest its paramountcy. Of late, right between those rivals, there sprang up the Star Theatre (moving pictures for man, woman and child) to outshine its neighbors by making itself an Aladdin's palace of incandescent lights. At this the dime museum announced: "Moving Pictures. Seats Free!" Now the Comique has hung forth two ultra-dazzling flaming arc lights, so that the Star is already reduced to the ignominy of the "toity cents" of proletarian parlance. What will come next in that battle of the lights goodness knows.

Aesthetically (I trust you have not condemned me unheard for speaking of æsthetic possibilities in connection with so harsh a form of radiance) the flaming arc lights' hideousness is the cause of beauty in its surroundings. Despite its dismal effect upon the human face, its effect upon buildings is magnificent, unveiling new beauties, illumining hid splendors. Not merely does it fill a whole vast space as with the glow from a conflagration, awakening within us a reminiscence of that fire-worship which is the joy of urchinhood; it throws architecture into bold relief, exaggerates chiaroscuro, makes a picture in the manner of Nicholson, with flat tones of light and masses of inky shadow. Nor is the flaming lamp alone in this art of wonder working. The same was true in the display that held the multitude breathless before the big department store. As is usual with crowds, they missed the real marvel, which was not the show of electric bulbs, but the picture made by their lighting of the Parker House. Viewed from the north, its upper stories had the look of a chateau in Touraine, while King's Chapel became almost a black silhouette, and might have been washed in by Gustave Doré. So with the flaming arc lamps before the Westminster Chambers. Hideous in themselves, they throw a new glory over the south transept of Trinity and add to the towers a new and unexpected splendor. What richness of color; what boldness of contour; what enticing mystery of shadow! Pass that way and see how the new horror has yielded a new loveliness.

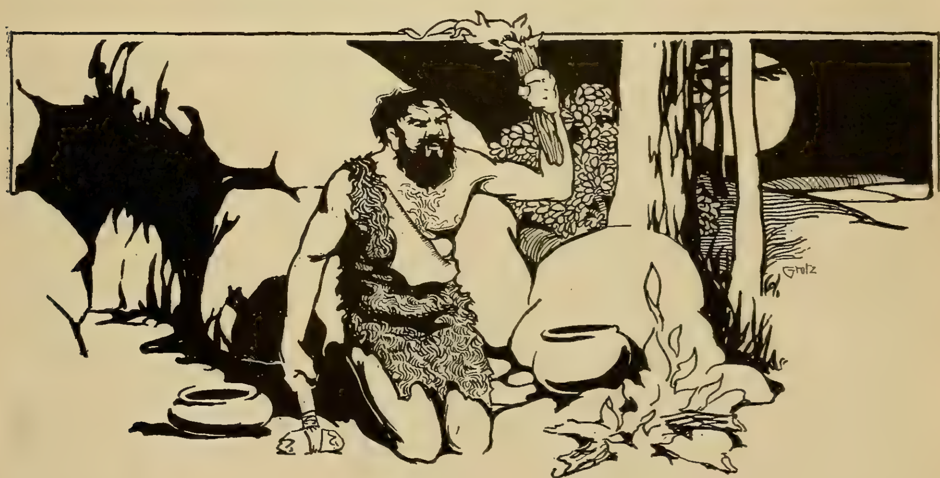
And the flaming bulb will do as much, sometimes, for the building to which it belongs. At the Y. M. C. A., for instance, the low relief of the facade becomes a Hugoesque contrast in lighted red and rich black. You would scarce have thought it capable of such beauty. The Dutch-gable effect over the doorway is emphasized superbly by the shadows thrown up from below. Sills and mullions, casting broad spaces of black, make the windows deliciously picturesque. Meanwhile the Berkeley Building reverses the theory. A hanging light just beneath its ivory cornice sheds a soft illumination half way down its front. The illumined portion, when seen from a distance, seems almost hanging in air—a miniature suggestion of a snow-clad peak still lighted by the setting sun after the valley is plunged in darkness so that the mountains's lower half is no longer visible.

And it is to the flaming light, rather than to the incandescent bulb or the old-fashioned arc lamp, that we owe the supreme loveliness of mist, the supreme glory of rain. Instead of "conquering a hemisphere of darkness," it makes the air luminous far beyond the borders of that hemisphere, turning all the surrounding space to palpitant, blowing, jubilant radiance. On rainy evenings it makes the pavements a mirror of fire.

But for reflections absolutely without equal anywhere in the world, view the West Boston Bridge at night. However splendid the illumined Seine, it is a poor show compared with the illumined Charles. Whereas other bridges send a glitter dripping zigzag fashion down the water, ours builds a colonnade of dazzling pillars—solid, almost. Instead of appearing to fall from the graceful arch, they appear to rise toward it.

They grow out of the water. They gain firmness as they grow. The bridge seems to rest upon them. And this illusion of bulk and solidity results from the happy selection of twin lights, of the Wellsbach type, each pair set so close together as to be one light, not two, when seen from afar. Hence the breadth of the pillar. Hence, in turn, its motionless beauty, while from its stillness, as from its bulk, you get a thrill as from something magical. At the same time you feel that spell of solemnity which is inseparable always from a great colonnade.

One dreads to think of the explosions of French rhetoric with which M. Camille Mauclair would greet the West Boston Bridge. Yet this, like our other experiments in "la décoration lumineuse," merely signalizes the beginning of a magnificent evolution. So rapid has been our progress within the last few years that one looks forward with curious and not unreasonable hopes towards triumphs as yet unattempted. No doubt the ensemble will be barbaric—even "brutal," to use M. Mauclair's word—for a long time to come. No doubt commercialism, rather than "l'art pour l'art," will for a long time govern the development of illumination in Boston. Perhaps it always will, for the most part. The frisky signs that pop up abruptly and as abruptly pop out again, the signs that turn from ruby to gold and from gold to ruby in sheer playfulness, the fiery rats that dart round and round a sign, the searchlights that play irreverent pranks with church spires—these and their ilk will remain, as why should they not? They contribute their quota of gayety and give the night-time city the aspect of a fair. Meanwhile, however, there is opportunity for ordered effects in illumination. While our architects are dreaming of new boulevards, enlarged parkways and coherent plans for a more comely and monumental city, why should they not plot out schemes for lighting that city in the most decorative fashion possible? The State House dome and the West Boston Bridge have shown what the Commonwealth and municipality can do. They are a worthy, even a triumphant, beginning. Nor does the matter rest solely with Commonwealth and municipality. "La décoration lumineuse," studied from the æsthetic point of view and set forth in its principles by a commission of architects, would have its influence upon the exploits of tradesmen who are now, purely from commercial motives, contributing so liberally toward the evolution of a city of beautiful night.



Studies of Notable Installations

Spectacular Lighting in the "Middle West"

It will be no surprise to the average American to be told that, on the whole, the Western cities and towns are far ahead of the East in the matter of spectacular lighting. Our Eastern neighbors will probably not even wish to deny that, the Westerner thinks faster, and follows thought with action more quickly, than they do. Furthermore, the Westerner is not at all afraid of being accused of imitating; and if imitation be considered a weakness, he removes this stigma by an honest effort to surpass that which served as a model.

Marion is a thriving, hustling town in the famous "gas belt" of Indiana. It is difficult to say just what its present population is, but at last accounts it was 19,908. Notwithstanding its location in the midst of the gas producing country, this city is a great be-

ELECTRIC ARCHES AND OUTLINING IN MARION, IND.

ELECTRIC ARCHES, MARION, IND.

ILLUMINATED COURT HOUSE, MARION, IND.

OUTLINED DEPARTMENT STORE, CANTON, O.

liever in the value of the electric light. The local supply company is known as the Marion Light and Heating Company, the central station supplying heat through a public distribution of steam. Something over a year ago the merchants and business men of the town took up the matter of public spectacular lighting; the first outcome of their efforts being the erection of permanent steel arches carrying incandescent lamps, in the principal business section. These are shown in Figures 1 and 2. In Figure 2 is also shown the inevitable result of public enterprise, namely, the private installation of outline lighting.

Figure 3 shows a still further step in the development of public spirit when once fully aroused. The county court-house was outlined effectively in December last, thus, as it were, setting the official seal of approval upon this kind of public enterprise.

Canton, Ohio, is not a metropolis, but it is a decidedly wide-awake and thriving town of some 32,011 population. While it has not yet taken up

A PROMINENT HOTEL, CANTON, O.

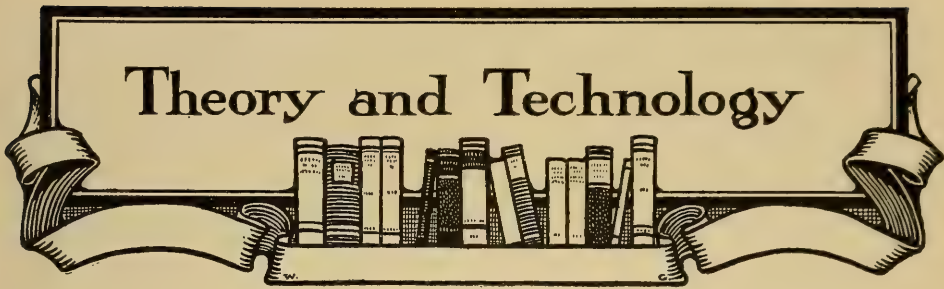
spectacular lighting as a public enterprise, the amount of private installations of this kind are so numerous as to give a decidedly wideawake appearance to the town at night, as the illustrations show. Where is the town of its size that can surpass it?

Wheeling might very properly be called "the Junior Pittsburg." In location, industries, and general hustle it is almost a counterpart of that center of industry, even to the smoke in the atmosphere. Within the past six months its principal business streets have put on a new evening dress. Spectacular lighting, once started, spreads like the traditional "wild-fire." Over 12,000 lamps have been put in within the period mentioned. A fair idea of the result is shown in the illustration. The local company is the Consumers' Electrical Company.

It will be no surprise for the reader to learn that all three towns mentioned are served by companies in which Mr. Henry L. Dougherty is the controlling genius.

ILLUMINATED AWNING, CANTON, O.

THE WHITE WAY OF WHEELING, W. VA.



Plain Talks on Illuminating Engineering

By E. L. Elliott.

XV. Spectacular Lighting

By Spectacular Lighting we mean to include all uses of artificial light that are intended primarily to attract public attention. This class of lighting therefore belongs almost entirely to the *art* of illuminating engineering; there is very little in the subject that pertains to the scientific, or engineering side. The one essential qualification for success is originality of conception. The most startling novelty very soon ceases to startle, and becomes a mere matter of course; and nothing is so stale as an imitation. To attempt to lay down rules for such work would, therefore, be a sheer waste of effort. We will, therefore, simply offer some suggestions which may help those who have occasion to design lighting installations of this kind to obtain effects containing the necessary elements of novelty and beauty to render them attractive.

Any kind of light is an attractive object at night, with the setting of darkness as a background. The two principal means of increasing this attractiveness are motion and color. The familiar orange-yellow color of flames and incandescent electric lamps is as familiar as the green color of foliage, and any variation of this prevailing tint will form an element of attractiveness. Colored lighting is most easily produced by the use of either colored electric lamp bulbs, or lamps with colored globes over them. There are, however, some rather serious defects in the methods of producing such color effects. The range of color which can be given to the glass itself is very limited, a very distinct, or solid red and green being the only practical colors. Blue is very easily produced, but absorbs the yellow of the lamp to such an extent as to make the resulting light very dim; and the solid red and green are rather garish for the higher artistic effects. Lamp bulbs are readily given any desired tint by coating them with a colored varnish, but as the coloring matter of these varnishes is analine dye, they are all, without exception, more or less fugitive. The production of a permanently colored varnish is as yet one of the unsolved problems. The intensity of light to which the varnish is necessarily exposed will sooner or later fade any color that has ever yet been produced, and the only solution of the problem is the frequent re-dipping of the lamps. This is regrettable, since the range of tints possible to obtain with the analine dyes is almost unlimited, and the colors are of such

purity as to give effects of marvelous beauty, but "they all do fade as a leaf." In a series of experiments some years ago the writer obtained the most lasting results from the use of gelatin as the coating material. For this purpose the hard photographic gelatin should be used, and a small quantity of alcohol added to the solution to prevent its frothing. The solution can then be colored with aniline dyes which are soluble in water. A very little chrome alum should be added to harden the gelatin. Lamps may be dipped in clear gelatin, and dried, and then colored by dipping in a solution of the dye. For outdoor use it would, of course, be necessary to either protect lamps behind glass or give them a coating of waterproof varnish.

The use of prismatic reflectors with colored lamps affords a field for pictorial effects which has been strangely neglected. There are possibilities in the way of exquisite blending of color and brilliancy of effect that far surpass anything that has ever been produced. If a colored lamp bulb be placed in such a reflector, on looking straight into the reflector the surface will appear colored. If the lamp bulb be colored in bands running either longitudinally or horizontally these colors will be taken up by the reflector, and blended into one another. By choosing a reflector of a flower-like shape, the effect of luminous blossoms having every conceivable tint or combination of tints may be produced. For example, the bulb may be given a yellow tint near the base, a band of red tint around the center, and green over the end. When the lamp is placed in the reflector the surface will be yellow in the deepest portion, blending into red, and that into green about the open end, while the green end of the lamp bulb will represent the center of the flower. Or, the bands of color may be run lengthwise, which will give the effect of a flower having petals of different colors. Beautiful effects are obtained by dipping the end of the lamp in a "frosting solution," and then coloring the other portion, giving the effect of a flower with a white center. These are only indications of the method to be pursued; the possible variations are endless, and are worth experimenting with simply for one's own diversion. By massing reflectors of different sizes, having lamps colored in this way, a veritable luminous bouquet can be produced. This offers an especially attractive method for decorating the fronts of moving picture theaters; by varying the arrangement of the lamps or colors, which can be readily done, the effects can be changed from night to night, or from week to week.

By a similar method, very beautiful results may be secured by the use of large Holophane globes having colored lamps hung within, and connected with a flasher by which the different colors can be lighted up. The globe entirely hides the light source, showing only the color of the light within. Thus, the globe may be made to change its color entirely; or, what is much more effective, it may be made to take different varigations. Thus, suppose, red, green, yellow and blue lamps are hung within it; if the blue and yellow lamps be lighted some of the facets of the prisms will show green, while others will show yellow; the effect will be indescribable and not only beautiful, but mysterious, which is always a powerful element of interest. The red and green make a similar combination that is beautiful.

The use of the mercury vapor lamp with its distinct peacock blue color has been taken very little advantage of in spectacular lighting. It furnishes a

COLUMN SURROUNDED WITH MERCURY VAPOR LAMPS.

most striking contrast when used with the yellow light of incandescent lamps, and could be used very advantageously in many cases to break the monotony of the too familiar lamp. For such purpose it can be most effectively used to illuminate transparencies of ground glass showing a monogram, trade-mark, or other similar device, which would be set off by contrast with the incandescents. The word "Erie" on the terminal station of that railroad in 23rd street, New York, is a conspicuous example of this use. It is exceedingly effective.

The flaming arc lamp has been much used for spectacular lighting by reason of its enormous flux of light. A single lamp, or number of lamps by themselves cannot fail to attract attention wherever placed; but with increase in the number of lamps their conspicuousness of course diminishes. The difference in color of the light is hardly sufficient to distinguish it at a distance from the color of incandescents. It would, however, be a very simple matter to make carbon which would give vivid and distinct colors. Red fire is the old standby in celebrations and pyrotechnic displays, but it staggers the imagination to think what might be done in the way of red light by using a carbon charged with strontium salts in a flaming arc lamp; or the possibilities of turning things green in a judicious use of copper salts. Here is a suggestion for those having some familiarity with chemistry to astonish the natives.

To produce the effect of motion by lighting up successive lamps is a trick that has been developed to a very considerable extent, and invariably proves attractive. The simulation of flowing water, as of a fountain, accomplished by this means is really wonderful, and the possibilities of these effects is limited only by the mechanical genius of the designers. We shall probably see this method developed to a much greater extent in the future.

The electric light has thus far had the complete monopoly of spectacular lighting; but this is by no means due to the fact that such effects are impossible with gas. If there is any doubt on this subject, we would refer to the most excellent article by Mr. R. L. Hartt, of the Boston *Transcript*, given elsewhere in this issue, in which he speaks of the element of life which the wavering and unmechanical motion of a flame gives. There is indeed an attractiveness in a flame which no fixed luminous surface can ever possess. It is not necessary to be limited in the use of flames to the ordinary gas jet. By varying the size, shape, and direction of gas flame the most fascinating spectacular results could easily be obtained, which would have the valuable additional quality of

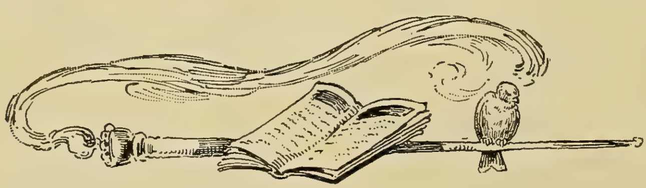
being novel. Gas lighting does not need to confess its defeat by the electric light, even for spectacular lighting. As a single suggestion, imagine a street having suitably designed lampposts with gas flames a foot or more in height issuing from a suitable burner at the top.

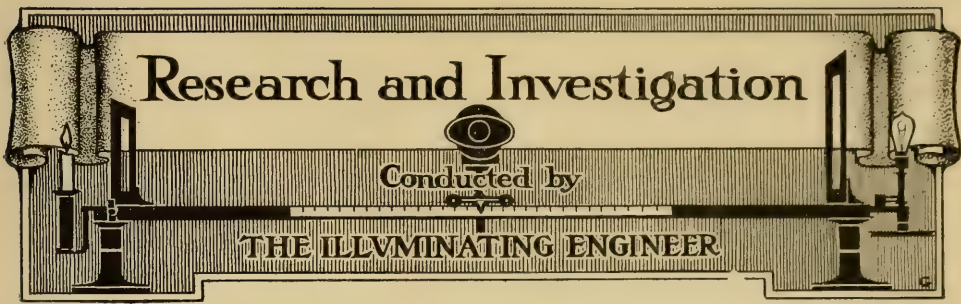
Another field rich in possibilities in spectacular lighting is the illumination of escaping steam. An elaborate scheme of this kind was worked out by Mr. W. D'A. Ryan, for the Charlestown Exposition, but was abandoned for lack of funds. In the case of any buildings having power plants, the exhaust steam, or a portion of it, might be used for this purpose with very effective results. A scheme of this kind was suggested for use in connection with the monument to be erected in Brooklyn to the "Prison ship" martyrs; mention of which has been made in a previous issue. The monument is in the general form of a lighthouse surmounted by a large urn to represent the method used in producing light in ancient times. A jet of steam issuing from the top of this, and suitably illuminated from underneath, would have given a very close simulation of fire and smoke, and would have been exceedingly effective, and visible for enormous distances.

The Moore Vacuum Tube Light should be included among the possibilities for novel effects of a spectacular nature. A continuous line of light of mild intrinsic brililancy, having to the ordinary observer the appearance of a band of luminous smoke or steam, would make an exceedingly attractive and agreeable variation in outline lighting. The long tubular incandescent electric lamps having the filament stretched out in a line from end to end could be utilized in the same manner. As lamps of this type are now regularly on the market in this country, there is an opportunity for the ingenius sign maker, or illuminating engineer, having such problems to handle, to evolve some striking and beautiful effects by the use of such lamps. They should be very attractive for large signs, and also for outlining. Used in connection with the ordinary type of lamp they would permit of effects that are impossible with the use of points of light alone.

The methods above mentioned will indicate somewhat the possibilities in this rapidly growing branch of illumination, and to those who have a mechanical or inventive turn of mind the field is not only attractive in point of interest, but offers opportunities for financial success as well. New and effective methods of advertising are always in demand, and will be paid for in proportion to their worth; and spectacular lighting is, at the last analysis, simply an advertisement.

Spectacular lighting is increasing in popularity and extent at a very rapid rate, and is a very fertile field for illuminating engineers having a talent for original conceptions and a quick appreciation of the adaptability of the various elements and effects that have already been produced.





The Effects of Polished Reflectors with Incandescent Electric Lamps

It is a very natural assumption that polished surfaces are the best for reflectors, but this is only true in a limited number of cases. Where it is desired to concentrate light on to the smallest areas, the polished reflecting surface must, of course, be used; and where the light is used only for general purposes and not for close eye-work, such reflectors are not objectionable. In all cases, however, where the eye must closely follow the illuminated surface polished reflectors with incandescent electric lamps have the serious defect of giving a very streaky and uneven illumination. While this fact is familiar to illuminating engineers, it is often either unknown or disregarded by the layman.

In order to show the effect of polished reflectors, we have had photographs made showing a sheet of white paper illuminated with a 16-c.p. oval anchored carbon filament electric lamp with metallic reflectors of practically the same form, one having a highly polished, and the other a "matt," or diffusing surface. The reflectors were placed 30 inches from the paper when the photograph was made. Figure 1 is the result obtained from the polished reflector, and Figure 2 from a matt surface reflector. The polished reflector was of burnished aluminum, and the diffusing reflector of steel coated with aluminum paint. In working under the illumination shown in Figure 1, the eye is subject to precisely the same injurious strain that is produced by a flickering light. Thus, in reading or writing, the eye passes from the light to the dark streaks more rapidly than the iris can adjust itself for the difference in illumination, and this continual effort at adjustment is highly fatiguing. Such an illumination thrown upon objects upon which fine work is being done, such as in accurate mechanical work, gives false impressions of the surface and contour by reason of the streaks of light and shade, and thus confuses the eye. For all careful work the illumination should have no such sharp variations in light and shade, but uniformity, as shown in Figure 2.

FIG. I.—ILLUMINATION FROM POLISHED METAL REFLECTOR.

FIG. 2.—ILLUMINATION FROM METAL REFLECTOR COVERED WITH ALUMINUM PAINT.

Editorial

BY
E. LEAVENWORTH ELLIOTT

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An English View of Illuminating Engineering

In the first issue of THE ILLUMINATING ENGINEER, London, Mr. Sydney F. Walker has an article entitled "Development and Present Position of Gas and Electricity for Lighting Purposes," at the conclusion of which he remarks that the present methods of generating light from both gas and electricity may be extinguished by the discovery of the light emitted by the fire-fly. *Electrical Industries,* London, takes occasion to sneer at this remark in an editorial attempting to belittle illuminating engineering. The arguments presented by our contemporary are still sometimes slyly put forward in this country to those who may be safely assumed to have little knowledge of the situation.

"It seems to us that the art (not science) of correct illumination should be grasped by the station engineer and the contractor. The illuminating engineer as a specialist is, to our mind, an unnecessary individual, and we scarcely think his importance warrants the publication of a special magazine for his entertainment or instruction."

The saving grace in this argument is the use of the word "should." No one will deny the propriety, or perhaps the advisability, of station engineers and contractors making themselves familiar with the principles of correct illumination. If this had been done in the past there might not at the present be a demand for the illuminating engineer as a separate specialist, although there would be none the less necessity for illuminating engineering. Electrical and gas engineers, contractors, and architects have had a perfectly free hand in these matters from the beginning of time to the present day, and the indisputable fact that artificial illumination is the most wastefully handled and carelessly used of all modern utilities is proof-positive that those who have been responsible for lighting installations have been either ignorant or grossly careless. In the memorable words of our ex-president, "It is a condition and not a theory that confronts us." It is generally admitted that the average methods of lighting

are wasteful of resources and inefficient in results; and as those who might, could, would, or should have done things better, have *not* done them, the only solution of the difficulty is for someone to undertake the task who *will* introduce the much-needed reforms. Although practical work of this kind has just begun, and for the most part has been carried out in the face of numerous obstructions which have often minimized the effects, the results have amply justified the demand for the illuminating engineer as a distinct specialist.

We are by no means ready to accept the statement, however, that station engineers and contractors should necessarily make themselves masters of the science *and* art of illumination. The extremely rapid increase in the complexity of all branches of science within the past quarter of a century has made frequent subdivisions necessary; and it is no more of a reflection upon the skill and training of an electrical engineer, or a contractor, for him to admit that he is not thoroughly conversant with illuminating engineering than it is for the general physician to send a patient to an oculist for treatment of the eyes. The professional man in these days who claims that he can do everything is not the one who is in demand by either the employer or the public. What is wanted to-day is the man who has an exact and comprehensive knowledge of some particular branch of business or handicraft, no matter in how narrow a field, and who can produce results in his specialty with unerring accuracy and skill. Electrical engineering began with the simple problems of telegraphy. To-day it covers a range of knowledge so broad and so deep as to be beyond the comprehension of any individual mind, with the possible exception of such rare geniuses as the late Lord Kelvin.

As to the light emitted by fire-flies; this has been the subject of study and research by some of the most eminent scientists of the world, and still offers an extremely attractive field for the student of pure science. The substitution of metallic elements for carbon as filament material for electric lamps has absorbed the attention of scientific investigators for a number of years past, by reason of the commercial results that seem within easy reach; but while the production of an electric lamp giving a definite amount of light with 1/3 of the current formerly used is a very great improvement, the actual result is very far from approaching the ideal of the scientist as exemplified in the light emitted by fire-flies. Ridiculing the possibility of scientific achievements in these days is an extremely hazardous undertaking, if one values one's reputation as a prophet, or even as a student of science. The production of luminous rays without the enormous waste of energy in the production of accompanying non-luminous rays is one of the triumphs of science which is bound to come sooner or later. Mr. Walker's prediction is far from chimerical.

The Annual Meeting of the Illuminating Engineering Society

Following the custom established last year, the Illuminating Engineering Society held its second annual meeting in the rooms of the Electrical Club on January 10th. The meeting began with an informal dinner, and ended early the next morning amid general congratulations and good feeling on the part of the departing members. The various annual reports were presented, the most important of which was that of the Finance

Committee, which showed that the Society had a cash balance above all obligations. Dr. Clayton H. Sharpe, the retiring President, reviewed the work of the Society during the past year, and formally handed over the office to the President-Elect, Dr. Louis Bell, who responded in a brief address full of enthusiasm and confidence for the future of the Society.

The Society now has 944 members in good standing upon its rolls, and has not only survived, but grown in strength and influence during its second year, which is always the critical period in the life of such organizations. Those whe were waiting to see it gradually fizzle out after the first outburst of enthusiasm had given it life, are doomed to disappointment. Illuminating engineering has demonstrated in every way its right to existence, and has forged ahead during the past two years at a pace unprecedented in the annals of scientific progress.

The 3rd Annual Convention of the National Commercial Gas Association

If any serious doubt ever existed as to the vitality of the National Commercial Gas Association it has been removed by the success of its recent convention.

The exhibition of gas appliances, which was a feature of the previous convention, was wisely omitted on account of the peculiar financial conditions immediately preceding. The value of such exhibitions, however, is very questionable under any circumstances. The real advantage of such gatherings is the recreation of those who attended. By recreation, however, we do not mean simply diversion and pleasure, but recreation in its literal sense. A large part of business is necessarily of the routine and treadmill order, which sooner or later deadens enthusiasm and narrows the mental horizon. The occasonal leaving behind of the environment and associations which, by reason of their constant familiarity, become a restraint upon growth and vigor, is an absolute essential to the highest mental and commercial efficency of the individual. Gatherings of this kind, in which we obtain a new perspective of affairs by virtue of seeing them from different viewpoints, and in which enthusiasm grows by feeding upon the enthusiasm of others re-create our energies, and furnish a new supply of fuel for the flames of inspiration, without which all labor is only a species of slavery. We see and hear enough of the material side of life in the course of business routine, without having it thrust upon us on these comparatively rare occasions when we have purposely left behind the workman and the vendor of wares.

The principal test of the success of a convention is the quality of the papers and addresses presented, and the general interest and enthusiasm with which they are received. Judging by this criterion, the convention was a pronounced success. The papers which have a direct or collateral interest to illuminating engineers are reviewed elsewhere in this issue. We would call special attention to that portion of President Clark's address which is there quoted. Mr. Clark's comments have a far deeper significance than the mere admonition to the gas interests which they contain; they show that the recognition of the fact that illuminating engineering includes gas lighting quite as well as electric lighting, and that the gas interests must act in accordance with this fact if they are to maintain their due importance in the field of illumination. That

illuminating engineering in this country has been monopolized to such an extent thus far by the electric lighting interests is not because its practice and principles do not include gas lighting, but because the electrical interests have been more alert in grasping its commercial significance. We grant that the electric light is more adaptable in certain ways than is gas light; but does not this call for greater engineering skill in securing given results, rather than eliminate it from the engineer's consideration?

It is gratifying to know that a great change of heart has taken place among the gas interests within the past year,—in fact, even within the past two months—in this regard, and the number of papers bearing directly upon the subject presented to this convention, as well as vigorous tone of the matter in the papers, is one of the most convincing evidences of the awakening interests in the subject among the gas companies.

The Age of Light

A new era in public illumination is dawning. The epoch of darkness relieved only by the few straggling rays of the watchman's lantern, or the occasional lamp suspended from the mansions of the wealthy, ended definitely with the advent of illuminating gas. Public lighting as a public utility has thus existed for the past century; but it is only within the past decade that public lighting has been recognized as a proper means of expressing public taste, enterprise, and civic spirit. To so light the street as to render it not only serviceable, but secure from the depredations of the lawless, was one of the great achievements of modern civilization, comparable to the suppression of piracy on the high seas; in fact, it was a much more important step, for in point of numbers the opportunities for crime in unlighted streets are far in excess of those afforded by the ocean.

But the modern city is much more than a mere collection of human habitations; it is a personality,—a composite of the characters of its citizens. The citizen expresses himself in his store, his office, his bank, his club, his residence: the collective expression of these various interests and tastes is found in the public places—the parks, the streets, and public lighting. It is to the credit of the American citizen that he never begrudges money honestly expended in the production of architectural excellence in buildings, generosity in the extension and beautification of parks, and thoroughfares in all public works. Even the lamentable misuse of the public funds which frequently accompanies public enterprise, has never quenched the pride of the American citizen in that which represents the government of which he is a part. The past year or two has seen a remarkable awakening to the fact that the illumination of a city is one of the most effective and powerful means of expressing the confidence and pride which the American citizen takes in his own town. Such illumination serves a double purpose; it is a thing of beauty and a constant delight in itself, and it may be made a most striking means of displaying the important features of the municipal commonwealth.

The whole matter of public lighting is one which demands careful and continuous study on the part of engineers who should be particularly charged with these matters. We, therefore, take occasion to again call to the attention of the municipalities the necessity of including an illuminating engineer among its regular employees.

Correspondence

From Our London Correspondent

MR. CHAS. W. HASTINGS,

Editor: *Gas Engineers' Magazine; Gas Engineers' Diary; Gas Engineers' Annual; Directory of Undertakings.*

Mr. Hastings has long been associated with gas engineering, having been a member of the Institution of Gas Engineers since 1877. His first published communication was an article describing the lighting of Billingsgate Marbel, London, by electricity in 1879. He took up technical journalism in the early 80's, and conducted the *Gas and Water Review,* which after about 10 years of publication was absorbed by the *Gas World.* Soon after this he accepted the editorship of the *Gas Engineers' Magazine,* and was a pioneer in the publishing of statistics of gas undertakings.

Some eighteen months ago, Mr. Hastings prepared a very exhaustive report on the work of the so-called "sliding scale' for the special commission appointed by the legislature of Massachusetts, and drafted a bill, which was adopted practically in its entirety by the Consolidated Gas Company of Boston, and which was later passed by the legislature. Mr. Hastings was one of the first of those interested in the production of luminants to recognize the importance of illuminating engineering, and has been our regular correspondent in the Gas Lighting field almost from the beginning of the publication of THE ILLUMINATING ENGINEER.

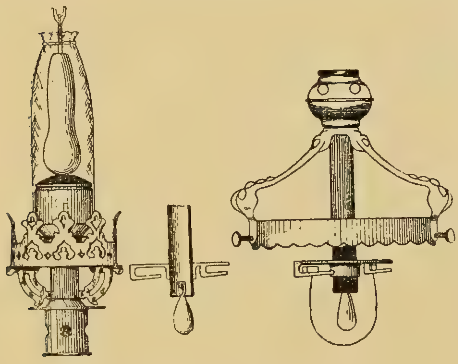
Those who have noted the increase in incandescence of the mantle of an inverted gas burner when the Bunsen tube is encased with magnesia or other material which will absorb, and afterwards radiate heat, will not be surprised that inventors are busy in that direction. Details have been published of the patent taken out by Messrs. L. H. & E. W. H. Eady and J. Cash. They propose to arrange within the mantle a solid body of fire-clay, steatite, magnesian clay, asbestos, or mixtures of such materials which will withstand the heat.

An example of the benefit of a cone or ring of material other than metal within the mantle is to be found in the very popular "Bland" and other burners. In the Bland burner the drop tube of the Bunsen has over it a ring of magnesia, which appears to serve two purposes; the gas travels down the tube comparatively cool, the flame

turns over, and then the outer ring quickly becomes incandescent as well as the mantle; in fact, the annular space between ring and mantle is charged with the flame, perfect combustion is obtained and the metal tube is protected.

In the patent under review with the upright burner, in place of the usual supporting rod a solid body, corresponding more or less to the shape of the mantle, as shown in Figure 1, is provided. This is of such a size as to permit of an annular space between it and the mantle, provision being made at the top for the "crutch" upon which the mantle is hung. The adoption of the same principle to the inverted burner is also illustrated; but we venture to think that with this form of burner the method adopted for the Bland burner is distinctly better, in fact, we question very much whether the pendant, pear shaped, solid heat-resisting material, would become as incandescent as the protecting ring on the Bunsen itself. The flame of an inverted burner needs to be much lower in the mantle than would be possible when using a pendant drop.

There would appear to be considerable discussion in electric lighting circles as to the merits and the advantages of using metallic filament lamps. Business is not brisk with electric



INCANDESCENT LIGHT IMPROVED.

lighting undertakings; extensions are not being carried out; public authorities are "holding their hands"; a wave of economy is passing through the land, and the journals devoted to electricity are bewailing the situation. The editor of *Electricity,* writing recently upon the subject, first quotes from the *Times Engineering Supplement* the following paragraph, with reference to the want of enterprise in electric lighting circles:

"One reason of this tendency to delay is undoubtedly to be found in the increasing scale of metallic filament lamps. With the carbon filament in general disuse it will only require about one-quarter of the present amount of current to supply the same number of public and private incandescent lamps. A financial crisis will be adverted by the advance of the price per unit to the limit of 7d allowed by the Board of Trade, which is almost double the present general average, by the immediate supercession of the many thousands of street gas lamps, and by the more vigorous development of power business."

The time was when an expression of opinion, even by the writer of an article in the *Times,* had weight, but surely in this instance the argument is absurd. The authorities are to double the price of the illuminant in order to popularize an economical electric lamp, which has at last been found; the consumer is to be penalized for using it, and his economical and brilliant incandescent gas burners, which have revolutionized street lighting throughout the United Kingdom, are to be supersessed"—whatever that may be,—in order to avert a "crisis." Really there is no great cause for alarm either for seller or buyer of gas. The Editor of *Electricity* is much more moderate in his views; he says: "The metallic filament lamp is slowly,

but surely, securing for electric light that measure of popularity which the incandescent mantle has already brought to the gas interests, both aiming at a reduction of the cost to the consumer without any corresponding diminution, but rather increase, in the quality of the illumination provided." At present it is quite impossible for the electric light to be supplied either as efficiently or as cheaply, light for light, as gas when consumed in an inverted gas burner.

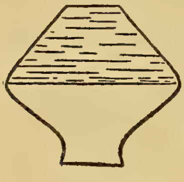
Readers of THE ILLUMINATING ENGINEER will be aware that the authority in London who controlled the mode of testing gas for illuminating power, pressure, and purity, are known as the Metropolitan Gas Referees. The present referees are Mr. C. V. Boys, Dr. J. S. Haldone, and Mr. A. Vernon-Harcourt, all gentlemen of high scientific attainments. It is the practice of the Referees annually to issue a "Notification." This year no startling announcements are made, the only changes being in regard to the method to be adopted in testing for illuminating power with the flat flame burner; the notification provides that the burner shall be Bray's burner, marked $\frac{G}{L}$ 5 ft. $\frac{10}{15}$, having a slit 0.028 inches wide. The test with this burner is a sort of auxiliary one, and is only for information; in accordance with the provisions of the London Gas Act of 1905, tests are now made with the Carpenter argand burner, or as it is officially described the "Metropolitan Argand Burner Wire."

The subject of the artificial lighting of schools has been reported upon by Dr. James Kerr, the Medical Officer of the Education Department of the London County Council. It will be interesting to give a short description of the photometer used. It is known as the Wingen, and consists of a metal box 8 inches high by 6.5 inches by 4 inches, within which, near one end, is placed a benzine lamp, the wick of which can be raised or lowered at pleasure. Outside the box is a small shelf covered with a white card upon which falls the rays to be examined. Inside the box is a similar white card lighted by the benzine lamp. The two white cards are viewed simultaneously at the bottom of a tube glazed with red glass, whilst the wick of the benzine lamp is adjusted till the cards appear equally brilliant. The value of the illumination is read off by looking through a small slit in the side of the box. A mark on the glass covering this slit is taken as a back sight, the top of the flame as a foresight, and the figure on the scale fixed upon the side of the box beyond the flame, in a line with the back and foresights, gives the value of the illumination in meter-candles. This instrument was tested against Harcourt's Pentane lamp, and was found to be correct for the purposes required.

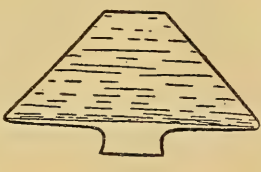
The majority of the schools are lighted by gas, either by incandescent or open flat flame burners. A trial was made of both systems in a class-room, there being four outlets. These were fitted first with Mr. Bray's regulator burners, and then with Welsbach "C" burners and "Calypso" shades. The gas consumed with the Welsbach burners was no greater,—perhaps less than with the Bray's fish-tail burners, but the desk illumination was increased nearly three-fold all over the room. The desk area was about 179

SQUAT CALYPSO, NEW NO. 3.

square feet, and the area of fair illumination with the flat flame burners did not exceed 26 square feet. With the Welsbach burners the illumination throughout the tests never fell below 10 meter-candles. Experiments have been made with a variety of shades, some of which we illustrate. The report draws attention to the inadequacy of such a form as the "Squat," the sides of which are at an angle of 45 to 50 degrees. The "Calypso" is somewhat of a parabolic reflector; the "New No. 3" differs slightly from the "Calypso" in the shape of the lower clear glass portion. The "Reflex" is considered objectionable by reason of the clear glass obtruding upon the upper angle of the shade; the improvement needed is illustrated in the 90° shade. An interesting experiment was made in which the meter-candle value of the illumination was measured on the desks immediately below the burner, and also at intervals of a yard along the horizontal desk tops which were vertically 5 feet below the burner. The results obtained with the "Squat," "Calypso," and "New No. 3," were practically alike, all being 1 meter-candle less than with the "Reflex" below the burner.



REFLEX.



L 90° SHADE.

RESULTS WITH "SIMPLEX" BURNER AND "C" MANTLE.

Shade	below	1 yard	2 yards	3 yards	4 yards	5 yards
None	1	2	2	1	1	1
"Reflex"..	8	8	5	2	1	1
90° Shade.	22	15	7	2	1	1

With reference to the general principle and arrangement of lights in a school the report says: (1) Each class-room should be considered as being made up of two portions, the children's area and the teacher's; and the lighting should be arranged independently. (2) Left-hand lighting must be arranged for as far as possible. (3) In calculating the area over which the rays of a lamp extend, only the rays that proceed from lamps in the front of the class, should be taken in the valuation. (4) There should be a clearance of 6 ft. 6 inches beneath all pendants, and the luminous mantle should be as closely as possible approximated to the level. Dr. Kerr evidently has not quite exhausted the subject of the illumination of schools; his remarks upon the inverted burner were crude, and prove that he is not in touch with modern invention and practice; the statement that with an inverted Bunsen burner the combustion is imperfect, and that noxious fumes escape to a much greater extent than with erect burners is not correct, for no system is more economical nor under better control, to say nothing of the light fittings that can be used. These advantages we would commend to all those interested in securing good light for the children.

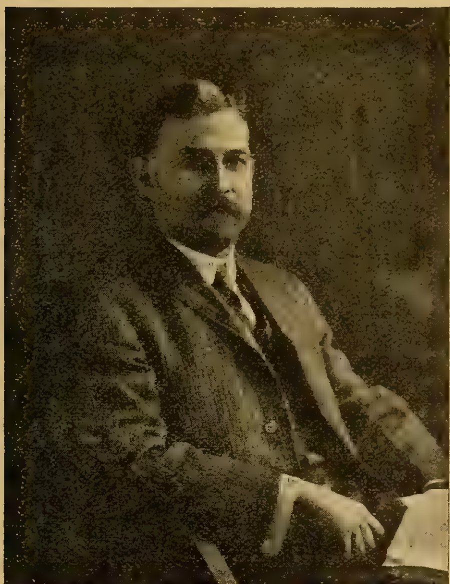
It may interest some readers to know that gas companies stocks have not been abnormally affected by the critical condition of the money market. It is true that prices have fallen, but business throughout the country has been good, and in many districts there has been a large increase in the sale of gas. Gas as an illuminant was never as popular as it is to-day; the consumer is getting value for his money, and with very few exceptions satisfactory dividends are maintained.

CHAS. W. HASTINGS.

London.

CASHIER BOOKKEEPER CONTRACTS ADVERTISING

Commercial Engineering of Illumination



HENRY L. DOHERTY,
The Pioneer of Commercial Spectacular Lighting in America.

That large branch of the electric lighting industry which we have designed "Spectacular Lighting," and which has made such rapid growth within the past few years, is largely the outcome of the personal genius and efforts of a single individual, whose name and portrait appear above

The possibilities of producing spectacular effects with the electric light, which in their reality far surpass the most extravagant fancies of legend or fairy tale, were exemplified in the illumination of the World's Fair in Chicago in 1893. The vision of the "Court of Honor," when the innumerable electric lamps outlined its majestic colonades against the deep blue of the lake or the sky, and transformed the stucco construction into veritable marble, was one which will always remain with the fortunate beholder. But this was only part of an exhibition, made with no other thought than to entrance and impress the beholder for a season, and then pass into history. That this same spectacle, differing in degree but not in kind, might be made a prominent feature of even the small western town, required a degree of foresight in conception and courage of conviction to carry into successful practice that very few men possess. But in the lighting field Mr. Doherty is not readily measured by the ordinary standards.

Mr. Doherty never lost sight of the commercial possibilities of lighting of this character; and at the present time it is fairly safe to assume in regard to a town that exhibits a particularly fine display of spectacular lighting, that its lighting company is under the direct personal inspiration and supervision of this master of illumination.

Some ten years ago, while managing some of the smaller lighting companies, Mr. Doherty originated the

midnight shut-off service for sign lighting, and the system of maintaining the signs on a flat rate basis. He was also the first Station Manager in the country to employ specialists in the work of developing display lighting. Five years ago when, as President of the National Electric Lamp Association, he predicted that sign and outline lighting would come to be considered as much a matter of course in business streets as in national expositions, he was looked upon by many of his confréres as visionary.

The "Doherty rate," which has been adopted by central stations in over 100 cities, has been an important factor in the commercial success of spectacular lighting, making the proposition attractive to a class of business where the previous rates were practically prohibitory.

During the year 1907 over 300,000 4-c.p. lamps were added to the load in the cities in which the Doherty companies operate, and in which the largest signs and most elaborate schemes of outlining, outside of New York City, are to be seen.

Spectacular lighting is a thoroughly sound commercial proposition, working to the mutual benefit of both the lighting company and the city; and while Mr. Doherty's enthusiasm on this subject has advanced the financial interests of the companies in which he is interested, it has also promoted the general welfare and public spirit of the towns to an equal extent. There are few other cases in which private dividends and public spirit are so closely connected.

The Westinghouse Lamp Co. Receivership to End

We are pleased to learn that the Westinghouse Lamp Company, manufacturers of incandescent electric lamps, and one of the constituent companies of the Westinghouse Electric and Manufacturing Company, have obtained the signatures of 99% in amount of the creditors to the readjustment plan permitting a discharge of the receivership. The receivers have found the company's financial condition to be entirely sound, the assets being approximately five times as great as its liabilities. The formalities conected with the application to the court, for a discharge of the receivers are now under way, and it is expected that the company will be returned to its shareholders by the first of March. The business of the company has continued without interruption during the receivership.

The officials of the company are expecting to have the new plant at Watsessing, New Jersey, in operation before the end of the summer. It will have a capacity of over 15,000,000 lamps per year.

Tantalum

Ekeberg, the Swedish discoverer of tantalum, gave that name to the metal because of the tantalizing difficulties that he encountered while investigating it. It is only recently that tantalum has been obtained in a state of purity, and the rapidity with which it has been produced, in response to the demands of commerce and industry, is almost unprecedented. It furnishes an excellent filament for electric lamps. Only a little while ago the mineral from which tantalum is obtained was so rare that not enough could be found to supply specimens to all the mineralogical museums. Now Australia alone produces more than seventy tons of tantalite a year. This does not seem a very great quantity, but it is to be remembered that a single pound of tantalum suffices to furnish 23,000 lamps, each of 25 candle-power. The metal is so hard that it is said that a diamond-pointed borer making 5,000 revolutions a minute produces in it after three days at work an excavation only one-fiftieth of an inch in depth.—*Youth's Companion.*

GATHERING THE EGGS.

Advertising and Prosperity

From the Journal of Electricity, Power, and Gas.

But these two cartoons ["Killing the Goose," and "Feeding the Goose"] are also indicative of what has been done in many other business lines whose watchword is "retrench." Some managers who now say, "I cannot afford to advertise," two years ago said, "I do not need to advertise." Then they were engulfed in the great wave of prosperity that filled their shops with more than they could handle. Now, when threatened with the reactionary wave of business depression, they neglect the one bulwark that will stop its course and store up business for them on a safer and saner level. The flood tide of renewed confidence is returning, and the wise man is preparing for it in this temporary lull.

With a meritorious article, there are but two fundamentals for business success; to find the market and to properly exploit it.

There is a further point in connection with this whole matter of advertising that deserves to be noted, viz., the close attention given the advertisements appearing in a technical journal. No matter how well the contents may be prepared, that portion of it represented by the announcements of prominent and progressive business men is by many readers deemed to be the most interesting. In the Editorial section there is always present the possible element of academic opinion. This is eliminated in the advertising assertions in the technical press. This part of a technical journal always affords the surest index of what may be styled the present state of the art. All that is therein claimed is entitled to the fullest measure of confidence, as it is the result of exact, costly and long-continued trial. The manufacturer of electrical machinery does not make his customers pay for his experiments; he has trial tests of his devices oft repeated till the standard of perfection is attained as nearly as possible,

and then he makes public announcement in the advertising columns of what is necessarily the newest in his lines. What he says is not theory or supposition, but may be relied on as being authentic, for he cannot afford to do otherwise. Hence it is that there is great truth in the remark of a reader that in the advertising columns he finds the latest electrical news, and consequently reads them first.

And, having tried the remedy, do not use it intermittently. A car that is started and stopped, and started and stopped, doesn't get there as soon as the one that runs right along. Not only that, but it wears out sooner, as the wheels and brake shoes are worn away and the cars racked by this disinclination of matter to stop. "Keeping everlastingly at it brings success."

Communications

From the Peerless Light Company, Chicago.

The Illuminating Engineer,
12 W. 40th street,
New York.

Gentlemen:—We enclose you herewith a circular showing our Peerless Home Lights in different colors. We have made a very big success of this home light and we think that the lamp itself could be made with interest to your readers. The question of light distribution is one which, of course, we all admit requires serious study and we believe that with our Peerless Home Lights we have solved the problem, so far as the home is concerned.

Individual light units properly distributed always look more artistic than large light units on a chandelier, in the home particularly. A large light unit means simply that one light will be lit in the home where there is a three or four-light gas fixture in the parlors, for instance, and the two or three lights, as the case may be, are not turned on. The result is a very inartistic combination. People spend money for fancy furniture, fine vases and other appliances to decorate the home and generally let their lights take care of themselves.

With the use of the Peerless Home Lights the softening effect of a shade colored to match the wall paper or the furniture can be secured while three or four lights can be lit at the same expense of one, showing the proper distribution of light units in the home to obtain the very best possible effects.

The fact that we have sold not less than 10,000 of these Home Lights during the last year without advertising even, is evidently sufficient proof of the statements herein made.

Yours truly,
Peerless Light Co.

From the H. W. Johns-Manville Co.

CONVENTION OF BRANCH MANAGERS OF THE H. W. JOHNS-MANVILLE CO.

In accordance with their usual custom, the H. W. Johns-Manville Co. held a convention of its branch managers, in New York, from January 29th to February 1st. The managers of the various branches of the company throughout the United States were present at the meeting and a general discussion of the business affairs of the company took place. As a fitting wind-up of the convention a banquet was given to the managers, at the Union League Club, on Friday evening, January 31st. The convention was pronounced a decided success by all present.

From the F. Bissell Company, Toledo, O.

The Illuminating Engineer,
12 W. 40th street,
New York.

Gentlemen:—It may possibly be of interest to you to be advised in regard to the system of illumination adopted in the new sales office of our company.

The office referred to is a room 38 x 56 and the ceiling is studded with 24 lamps equally divided into six rows of four lamps each.

187 Watt Gem Lamps are used in connection with Holophane bowl reflectors No. 6080 and the lamps are hung on an 18" stem, the height of the ceiling being 12'.

The result is practically perfect office illumination with the abolishment of shadows, etc., and it is a matter of pride with us that on no desk are stand lamps used nor are they necessary.

Very truly yours,
The F. Bissell Co.,
W. P. Bissell.

The Value of the Window

"I pay $2,500 a year for this shop," said a tradesman, "and $2,000 of that is for the window. Therefore, to make it pay its way, I am justified in giving my window four-fifths of the time I am able to give to displaying my stock.

How many tradesmen have as keen an appreciation, says the *Ironmonger's Chronicle,* as had this man of the real money value of a shop window? How many even realize that their shop rent is so largely fixed by the relation the window bears to the pedestrian traffic of the town? Owners of business property are not blind to this consideration; the value of the window as an advertising factor has a large share in fixing the rent of a shop, and if the tenant does not make the most of his opportunity he is paying too much for his situation. Let him, for instance, ask himself what the effect on his sales would be if he glazed his window with opaque glass, which would still admit light to his shop while it effectually shut out all view of what he had in it. Would the result be to increase or lessen his turnover? We do not need to answer our question. It is painful to see how many storekeepers act as if they really believed the opaque window would be a profound stroke of enterprise. They "go just one better" in improving on the opaque glass by a display that is calculated to bewilder rather than entice the passerby. Indeed some displays are as effective as the opaque glass would be. The latter might arouse curiosity; the show of goods can arouse nothing but distaste.

The shop window is an advertisement, and an advertisement that is dearly paid for—an expensive advertisement for a local paper or for a circular, a good deal of thought and preparation is given to it. It has got to be paid for in hard cash, and we want it to bring in at least the money it is going to cost us. How seldom the same thing is borne in mind in considering the shop window? And yet it ought to be the first consideration. If the proportionate share of window or windows to an entire shop rent would bring the value of the former to $1,500 a year, those window advertisements must net $30 a week to cover their money cost alone. The kind of display which draws the most observers to the window, and from their inspection of the window into the shop should be noted.

A leading manufacturer adopted for one year a new plan of introducing his goods. He instructed his travelers to stop soliciting orders and in place of that to arrange with as many retailers as possible to give special window displays of his goods, he furnishing the goods and his own men arranging the displays. The result was that most of those retailers sold a much larger quantity of the special wares than they had ever sold before, and the manufacturer himself disposed of nearly double the amount of any previous year's sales. That was a very good test of the value of window shows. It was a conclusive proof that the window is an advertisement and a paying advertisement if sensibly used. We commend the lesson it teaches to every business man. There is no storekeeper, whatever line he handles, who cannot make fifty-two effective displays in a year, if he will take the trouble.—*The Storekeeper.*

Proceedings of Technical Societies

Address of President Clark at the Annual Convention of the National Commercial Gas-Association January 8, 1908

President Clark laid particular stress on the necessity for greater energy and more intelligently directed efforts by the gas interests in the way of promoting gas illumination, in order that gas may hold the proportion of this part of the business which should naturally accrue to it. On this subject he said:

"Taking up the paragraph in regard to the President's address in which it says that 'he shall make recommendations as he may deem of advantage to the Association,' I should like to lay stress upon one or two points which should be accentuated.

"In one of the technical journals of the lighting field there recently appeared an editorial upon the future of gas lighting, in which the suggestion was made that gas lighting is being driven to the wall by the electric light. If this be so (which of course the gas man is not willing to admit), then it behooves the gas man to be up and doing. I believe it to be a fact that the gas man has given his best energies during the last few years to developing the gas fuel output, and has consequently, to a certain extent, neglected the lighting field. He has, so to speak, rested on his oars after the tremendous stride which was taken in the gas lighting field through the advent of the incandescent mantle.

"I think this is made apparent by his lack of interest in that most important branch of his art—Illuminating Engineering.

"The discussion of lighting problems in the Illuminating Engineering Society show a woeful lack of papers and discussions by gas men. A glance over the transactions show that the time is almost wholly given over to the electric lighting problems, and for this, I think, the gas man is wholly to blame. I have attended many of the meetings and find only a handful of gas men in attendance and few of them taking part in any of the discussions. This is not because they are not welcome, but by reason of the fact that it is almost impossible to get the gas men to take a lively interest in the proceedings, and I think this is one of the sources of the editor's impression, who wrote the article referred to, and who says further on: 'It would be interesting and highly instructive to see what could be done for rehabilitating gas as a first-class illuminant by the application of the same quality of energy, progressiveness, originality and perseverance in presenting its possibilities to the public that is displayed by the majority of central stations.

"I think it is generally conceded that the gas companies have made very little effort toward educating the public in regard to modern methods and possibilities of gas lighting, and what I wish to lay particular stress upon, is the necessity of the gas companies entering into a systematic educational campaign along these lines.

"In almost every home, shop and office we see evidences of a woeful waste of our product, through glaring faults of light distribution. It has been stated by those qualified to express the opinion that fully 50 per cent. of the light produced at the burner is wasted.

"Let us look for a moment at what this means to the gas consumers in the matter of dollars and cents. Quoting 1905 figures, the amount of our product which is sold annually in the United States, approximates 112 billion cubic feet—worth, say, in round numbers, 112 million dollars. Let us allow, say, 40 per cent. of this amount for purposes other than illumination and we have, say, 67 billion feet for illuminating purposes.

"Now, if the experts who made the esti-

mate as to the loss or waste of 50 per cent. of this vast amount through unintelligent and wasteful methods is approximating a correct statement, then there are some 33 million dollars worth of gas wasted annually in the United States.

"The possibility of the saving of even a small proportion of this to the consumer, or better still, by diverting it to a useful channel and applying it to even out the load, makes it a wonderful field for operation. I put this forth as one of our most vital problems for your solution."

On the important question of the relation of gas companies to the public, President Clark's remarks are so forceful and to the point that we give them in full:

"One more thought which I would like you to carry away with you and which also means an educational campaign, is the establishment and promotion of *good will.* We hear much discussion in relation to the intangible assets of a Public Utilities Corporation and looming up prominently is this most valuable asset—*good will,* without which the corporation is badly handicapped. No matter how much energy and money is expended by the management, unless the feeling of co-operation and heart interest in the work is cultivated in the employees, much of the energy and money goes to waste. I am a firm believer in the efficiency of the educating of the employee. The prejudice for or against the company by the public lies almost wholly in the hands of the employees, and if they are discourteous or careless in their methods it reflects directly upon the management and the public takes it for granted that if discourteous methods prevail it is because they are sanctioned by the officers, or those in authority.

"It would pay us to spend a lot of time and money in educating the employees up to a realization of the importance of tactful and business-like methods. There are many ways by which this may be accomplished, the best of which I believe to be, the organizing of Progress Clubs which shall have frequent meetings at which interesting conferences may be had—lantern-slide exhibitions given—and object lessons showing workmanlike methods of handling appliances.

"At these meetings all the departments should be represented. These matters are such as I should think should come directly into the province of the members of the National Commercial Gas Association, and the best methods for their promotion should be worked out by our members.

"As to the future of this Association, it is safely assured. What we have accomplished in the past is an indication of what we have only begun to do. We are growing in numbers and importance in the industry each day and with the return to normal financial conditions which the near future promises, and with which will come the hearty co-operation and enthusiasm of all, we are bound to eclipse all our past achievements."

The Commercial Side

Address of Prof. A. C. Humphreys before the National Commercial Gas Association, January 8, 1908.

Dr. Humphreys' address on this subject is of particular interest by reason of the broad view which he takes of his subject, and also from the fact that he speaks as a successful commercial engineer, as well as a recognized authority on not only matters of gas engineering, but of the entire field of technology. He begins with the following propositions:

"We are constantly hearing discussions as to the relative importance of certain elements necessarily found in many undertakings; for instance:

Theory *or* Practice;

College Education *or* School of Experience Education;

Technical Management *or* Business Management;

Labor *or* Capital;

The Book tells us: 'Eye cannot say to the hand, I have no need of thee.'

If we change the 'ors' to 'ands,' the question in each case is resolved."

Following the line of thought indicated, he then makes an appeal for a closer co-operation between the purely technical, or engineering, and the commercial elements in the operation of the gas industry.

On the question of specialization his advice is particularly sound:

"To refer to the engineering side, see how the advances in engineering science during the last 50 years have brought about a further differentiation. Now, instead of the simple classification of Military Engineering and Civil Engineering, we have the latter divided into Civil (as a section of the field only), Mining, Mechanical, Electrical, Marine, Chemical, Electro-Chemical, Sanitary, etc. Then most of these divisions are being again sub-divided and re-subdivided. The gas men and electric light men are not always in opposition, so we find them working together as illuminating

engineers. This division and sub-division of the field of engineering necessarily leads to much overlapping and this has resulted in the discovery that only by affiliation on the part of the several engineering societies, can the best results be obtained. Sometimes this effort at affiliation is governed by geographical considerations, but I am particularly referring to professional or vocational affiliation."

The necessity, from the purely commercial standpoint, of dealing fairly with the public, and of educating all employees to an appreciation of this fact, is briefly but vigorously set forth. The author then discusses at some length the question of cooperation of different scientific societies, referring particularly to the National Commercial Gas Association, and the American Gas Institute.

How Best to Harmonize the Work of Solicitors and Sales Methods in a Combination Gas and Electric Company

By George Williams.

Paper Presented to the National Commercial Gas Association Convention, 1908.

Mr. Williams believes that "there should be only combination sales departments employed in combination gas and electric concerns," and his short but convincing paper is devoted to proving this proposition. He makes the following suggestion as to the conduct of independent gas and electric companies, which is well worth their careful consideration:

"Harmonizing of separate gas and electrical interests might also be profitable in those instances where a gas company and an electrical company in the same city are both devoting valuable time and energy in the work of traducing and depreciating the merits of each other's product. There is abundance of business, either gas or electrical, which is yet accessible, without the need of malicious or ignorant statements from one company against the other. A volume of business from either company equivalent to $10 per capita in any city would still find a considerable number of kerosene lamps or coal stoves in use, and it is not probable that any of us here will see the entire extermination of any of these commodities."

How Far Should a Gas Company Go Toward Maintaining the Efficiency of Gas Appliances

By J. C. D. Clark.

In order that gas appliances may be maintained on a generally high plane of efficiency, Mr. Clark makes the following suggestion:

"The National Commercial Gas Association to recommend to the American Gas Institute the appointment of a committee composed of three members of the National Commercial Gas Association and three members of the American Gas Institute, to devise a way, or means, toward the installation of a permanent testing laboratory where all gas appliances coming on the market might be thoroughly tested by competent men to be known as the 'Board of Gas Appliance Examiners.'

"It would be proper for them to give in a pamphlet form their recommendations regarding the installation and operation of the appliances tested by them, and so far as possible have this pamphlet accompany the appliance. It could be gotten up in such a manner as to be acceptable to the manufacturers and those concerned in its sale.

"This pamphlet would serve as an educator to the salesmen, installer and the customer. The Board could in time establish a standard for all gas-burning appliances. Their work would go a long way toward encouraging the manufacturer who is inclined to build good appliances, and would tend to discourage the sale of worthless appliances.

"The Board should compile an illustrated pamphlet or book showing by simple diagrams, etc., the principles involved in the use of gas, precautions necessary to secure the best results, and in maintaining them and giving a brief and effective statement of the advantages of gas over other sources of heat and light. Every gas user should be provided with a copy, and if practical, a monthly pamphlet should issue.

"It seems to me that such a distribution of knowledge would more than repay the cost of publication, etc., in the increased satisfaction of the customer who now blames the gas for all the trouble he has with a gas appliance the operation of which he only half understands."

Gas Lighting in the Factory

By T. J. Litle, Jr.

Presented to the National Commercial Gas Association Convention.

By way of preface to his practical discussion of the application of gas lighting for factories, Mr. Litle says:

"The principal difficulty seems to have been that the engineer has not given the subject the consideration it warrants. If he should study the subject from its logical standpoint,—that of comparative cost, many of them would be quite astonished by the comparison, particularly with the electric light.

"From the power standpoint, any invention which shows increased economy, such, for instance, as triple and quadruple expansion and condensing engines as compared with the old type of simple engine, is given the most careful thought by the fraternity, and every engineer knows the state of the art in this direction; but when it comes to matters of illumination very few are prepared off-hand to discuss the matter.

"A campaign of education is necessary in order to bring this forcibly to the attention of the public."

Observations of the Methods of Handling the Lighting Industry Abroad

By R. M. Searle.

Presented to the National Commercial Gas Association Convention.

The author quotes at length from papers by Mr. John C. Tooms and Mr. F. W. Goodenough, which have been previously noted in our columns. Among his own observations he begins with the following:

"The first thing that impresses one is the extreme neatness of offices and appliances. The exhibits of appliances are always arranged attractively, properly and neatly connected for prompt demonstration, and show every evidence of being blacked, polished and inspected daily. One does not find the streaks left from striking matches on appliances, tray pans full of dead flies and price tickets, that one would have to take a nail brush and soap to find the figures. Then the long time association with appliances has resulted in all the employees being intelligently familiar with the various commercial uses of gas, and, therefore, able to answer questions right off the reel."

Practical Talks on Light and Illumination

By V. R. Lansingh.

Presented to the National Commercial Gas Association Convention.

In this paper Mr. Lansingh gives some of the most elementary principles of illuminating engineering, particularly explaining the photometric curve of distribution, and applying the explanation to the curves of the several types of gas burners, and globes and reflectors used with them.

The closing paragraph of his paper bears upon a very important point to the gas industry:

"One more point I wish to briefly dwell upon before closing this paper. In order to be the best solicitor in your company, you must know not only all about your own line, but also about our competitors'. The electric man has been putting on recently the famous three-league boots and is striding forward with great rapidity. To-day he is able to furnish lamps, which for the same candle-power, takes only one-third of the energy which was ordinarily consumed even a year ago. In other words, he has made almost as big a step in advance over the old type of lamp as was made in your line of work when the mantle burner superseded the flat flame burner. This, of course, cut down the one great point which has always been in favor of gas over electricity, namely, its economy. If we take gas at a dollar a thousand with a good mantle burner and compare it with a Tungsten electric lamp, consuming current at the rate of 10 cents per kilowatt hour, we find that for the same amount candle-power the electric light is less than twice as expensive. Let that fact sink in, Mr. Solicitor. With all the advantages that the electric light possesses, it is now nearly as cheap as gas, and, therefore, it becomes absolutely essential for you, Mr. Solicitor, to be posted as to the latest developments in your own line if you are to hold your own with your electric competition. And if you wish not only to hold your present position but also rise to one of much greater responsibility, you should be thoroughly posted as to how to give the customer the very best possible results for the money paid your company, and it is to awaken your interest along these lines that this paper is submitted."

Meeting of the Pittsburg Section of the American Institute of Electrical Engineers

The Pittsburg Section of the American Institute of Electrical Engineers met Wednesday, January 8, 1908, in the Carnegie Institute Lecture Hall, for the purpose of discussing "Illumination." One of the principal papers of the evening was given by Arthur J. Sweet, of the Westinghouse Lamp Company, of Newark, N. J.

Mr. Sweet first reviewed the theoretical factors of good illumination, classifying them under the following subjects: Efficiency of illumination, intrinsic brilliancy of light source, color, intensity, steadiness and efficiency of light distribution, size of illuminating source and the temperature to which it is possible to raise the incandescent solid.

The following table gives a comparison of the physical properties of the most common forms of electric lamps:

Kind of Lamp.	Mean spherical candle-power.	Watts per candle.	Candles per kw.
Common 56-watt carbon-filament incandescent lamp, rated at 3.5 watts per candle, 16 horizontal candle-power...	13.2	4.24	236
Common 50-watt carbon-filament incandescent lamp, rated at 3.1 watts per candle, 16 horizontal candle-power...	13.2	3.78	264
Three-glower, 264-watt Nernst lamp....................	81.	3.26	307
Gem, 125-watt, graphitized-carbon-filament lamp of 50 horizontal candle-power	40.7	3.07	326
44-watt tantalum lamp, rated at 22 horizontal candle-power	16.0	2.75	364
Direct-current 5.1-ampere enclosed-arc on 110-volt circuit, 1.5-in. carbons	213.0	2.63	380
Alternating-current enclosed 5.7-amp. arc, taking 388 watts on 110-volt circuit, .5-in carbons	152.0	2.55	392
60-watt, 110-volt tungsten-filament lamp burning at 1.25 watts per horizontal candle.........................	37.0	1.62	617
Luminous 8-amp. arc, 440-watt, two in series on 110-volt circuit	1020.0	.431	2320

Mr. Sweet stated that the filaments of tungsten lamps are now spring-anchored, and the lamps can be used in any position. He said that a tungsten lamp can be operated at double voltage for over an hour without burning out, while a carbon-filament lamp would last only a few seconds.

How Are We to Protect Our Eyes from the Effects of the Ultra-Violet Rays Yielded by Artificial Source of Light?

By Fritz Schanz and Karl Stockhausen.

Paper read before the Versammlung Deutscher Naturforscher und Aerzte.

Dr. Schanz refers to the experience of his collaborator (Dr. Stockhausen), who experienced severe inflammation of the eyes after working with an electric arc lamp. Many experiments have proved that this effect is caused by the ultra-violet rays. These rays are invisible to the human eye, but produce powerful chemical effects, and are easily recognizable by their action on a photographic plate.

Hitherto, a glass plate, placed between the eyes of the observer and the source, has been considered adequate protection, but this did not suffice in the case to which reference has been made. Dr. Stockhausen wore his spectacles, while making these experiments, but, nevertheless, suffered severely. This circumstance induced the authors to undertake an investigation, with the object of determining to what extent glass really does absorb ultra-violet rays. It was found that the usual glass lampshades, and the glass used in spectacles, only absorbs rays of shorter wave length than about 300 $\mu\mu$, and these are known to be just those rays which possess the least "penetrating-power," and are, therefore, least deep-seated in their action on the human organism.

The most powerfully active rays are those between 300 and 400 $\mu\mu$, and these are transmitted by the glasses referred to. The

so-called "blue" glasses, in fact, so far from affording additional protection, allow these rays to pass through with special ease. Smoked glasses weaken these rays, just as they do the visible spectrum, without completely suppressing them, however

The authors have also investigated the richness in ultra-violet rays of many artificial sources of light, ranging from the torch-light and oil-lamp to the new quartz-glass mercury lamp. Briefly, the intensity of the ultra-violet elements became more and more marked with rising temperature. Yet no general attempt has been made to suppress these rays, which are quite useless from the point of view of illumination.

Everyone must have noticed how quickly the eyes tire when we attempt to execute a piece of work by artificial light, which we are only just able to get through in daylight. The light "strains" the eyes. When the eyes are already subject to slight inflammation, the effect is more marked still.

Diffused sunlight is not very rich in ultra-violet rays, because our atmosphere absorbs them very markedly, and also because a very large proportion of such light is lost by multiple reflection, before the light reaches our work-table, and, eventually, our eyes.

The lens of the eye protects the retina from the influence of ultra-violet rays. When strongly illuminated by ultra-violet rays, the lens becomes fluorescent. The ultra-violet light has, therefore, been converted into visible light.

This naturally raises the question, whether the energy continually striking the eye may not, in time, effect appreciable alterations in the organ.

Widmark, Schuleck, and other workers, have detected a cloudy formation in the lens under the influence of ultra-violet rays.

The authors therefore suggest that the various forms of cataract might be initiated in this way. It is not easy to prove, definitely, that this cloudiness of the lens of the eye is more prevalent than previously, when we had no sources of light which were rich in ultra-violet rays. Yet this possibility must be borne in mind.

We ought, therefore, to seek to protect our eyes from ultra-violet light, not only because of its irritating effect on the anterior portions of the eye, but also because of the possibility that the cataract of old age may be appreciably accelerated thereby.

It is desirable, therefore, to utilize a variety of glass which absorbs these rays more completely than the glass in general use.

The authors have succeeded in producing such a glass, which, they hope, will be put on the market very shortly.

The Illumination of Work-Places and Work-Rooms

By Karl Stockhausen.

Paper read before the Versammlung deutscher Naturforscher und Aerzte.

Dr. Stockhausen remarked that a distinction must be drawn between the influence of the visible and the invisible rays upon the eye. But the dazzling effect of visible light of too great intensity is also injurious. From a hygienic point of view, the brightness per unit area of an illuminant should not, the author thinks, exceed 0.75 candle-power (Hefner), per square centimeter of radiating surface.

The author traces the continually increasing surface-brightness of modern illuminants, and compiles a table giving details of 40 different sources of light, ranging from the ancient pine-torches and oil-lamps, up to the inverted incandescent mantles and the newest metallic-filament glow-lamps of the present day. With the exception of the torches, candles, open oil-lamps, and flat-flame gas flames, all these sources exceed the limit mentioned above, and should, therefore, be enclosed in suitable diffusing globes and reflectors.

The continually increasing brightness per unit area of gas lights reaches a maximum in the acetylene flame and the inverted gas burner.

The new metallic-filament lamps, and especially the Nernst lamp, with a surface-brightness of 460 c.p. per square centimeter, are examples of a similar tendency in glow-lamp manufacture.

The brightness per unit area of the petroleum lamp is five times the safe value, and, similarly, the surface-brightness of the incandescent gas-light is 8 times, the carbon filament glow-lamp about 100 times, the metallic glow-lamp up to 270 times, and the Nernst lamp may be as high as 550 times the above value. Worst of all is the electric arc, the brightness per unit area of which is no less than 4,000 times that which the hygienic aspects of illumination demand.

The fact is emphasized, therefore, that

all such sources of light, when intended for the illumination of work-rooms, ought to be screened by the use of more or less dense diffusing shades. The most satisfactory system of all would seem to be inverted lighting, for, in this case, the dazzling effects are avoided, and the injurious ultra-violet rays are, for the most part, absorbed by successive reflection from the walls and ceiling.

The author points out further that, owing to the faulty construction and use of diffusing globes, brightly illuminated spots are often met with, which exceed the permissible brightness per unit area by 2 to 3 times.

Finally, he remarks that, during the competition between gas and electricity for lighting purposes, it has become customary to aim at mere brilliancy of illumination, and either to omit the requisite diffusing shades entirely, or to place them in such a way as to throw the light downwards, instead of screening the eyes of the worker.

The author closes his paper with the following recommendations:

(1) All sources of light should be screened by diffusing shades, placed in such a position that the eye is unable to perceive any light-radiating surface of a brightness exceeding 0.75 c.p. per square centimeter.

(2) Chimneys or globes should be made of some variety of glass which absorbs ultra-violet light.

(3) Globes must be sufficiently dense, and constructed in such a way as to enclose the source, and to present an evenly and weakly illuminated surface to the eye.

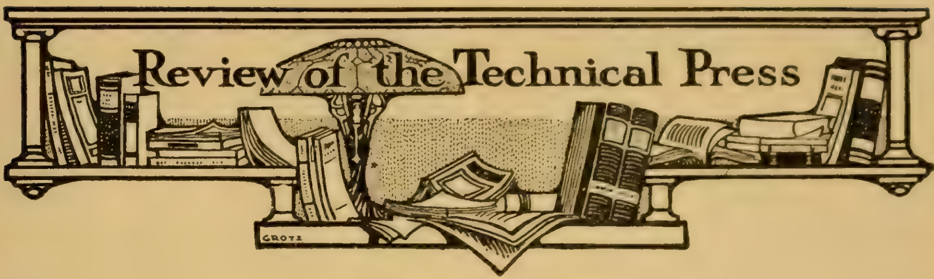
(4) Glow-lamps with clear globes should be rejected for the illumination of schoolrooms and work-rooms.

(5) Inverted illumination is preferable (from a hygienic standpoint) to all other methods of illumination.

Electricity as a Factor in Advertising

The relation of Electricity to advertising in its most utilitarian aspect is not intricate, nor does it involve abstruse considerations such as are ever present in the mental processes of the ad-writer in the preparation of copy for even the most simple five-line "want-ad"; but it is, however, well worth studying. The science of advertising changes rapidly to meet the varying conditions of supply and demand, of media, of environment, of trade relationships and of exigencies of business requiring immediate and forceful publicity, but the art of employing materials at hand to produce desired results follows lines which are to a very considerable extent subject to fairly well defined laws which are framed inevitably for appeal to that court of last resort, the human eye. In other words, the fundamental law with respect to all forms of Advertisement is based upon its appeal to the vision.

That this deduction is correct is amply proven by the enormous increase in the use of illustration in advertising, as well as the universal recognition by advertisement writers that much depends upon the display, form, and effective typographical setting of the advertisement. It will thus be seen that consciously, or unconsciously, the appeal of the writer of advertisement is not primarily to the quality of reason, but to the sense of sight, and continuing in sequence still farther along this line of reasoning, we find the fundamental bases of all advertising to be optical, physiological, æsthetic, and utilitarian. This brings us logically to the illuminated advertisement, par excellence, *i. e.*—the *Electric Sign*, the Electric lighted show window, the Electrically illuminated store, and the Electric lighted street.



American Items

ELECTRICAL WORLD, February 1st.:

Modern German Arc Lamp Photometry;

Gas Photometry and Study of Illumination of Interiors;

Changing Show Window Lighting to Flat Rates;

Renewal of Expensive Lamps;

Rational Fixture Design.

HIGH EFFICIENCY LAMPS IN KAISERLAUTERN, GERMANY, by L. J. Auerbacher; *Electrical World*, February 1.

ARTISTIC ILLUMINATION: MURRAY'S RESTAURANT, NEW YORK CITY. by H. Thurston Owens; *Electrical World*, February 1.

Describes the lighting, scheme, and gives numerous illustrations showing the decorations and elaborate fixtures of this installation.

Some of the statistics on January 1, 1907, were as follows:

Area, 124 square miles.

Unimproved streets	437 miles
Paved streets	369 miles
Total streets	806 miles

Lamps.	Candle-power.	Number.
Arcs	1,200	2,523
Incandescent	25	175
Mantle Gas	60	3,409
Mantle Naphtha	60	738
Total		6,845

STREET LIGHTING IN THE CITY OF NEW YORK: SUBURBAN LAMPS, BOROUGH OF QUEENS; by H. Thurston Owens; *Progressive Age*, February 1.

Gives statistics as to a number of different kinds of street lamps, specifications in the lighting contract, and ilustrations of the different forms of gas lamp and lamp posts used.

THE TANTALUM LAMP IN CENTRAL STATION SERVICE AT MUNCIE, INDIANA, by George C. Osborne; *Electrical World*, January 18.

Situated in the central part of the State of Indiana is the city of Muncie, possessing about the same opportunities and limitations to the central station as the ordinary city of 30,000 inhabitants. With an abundant supply of natural gas, distributed by five or six separate companies, and a widespread use of gasoline for individual lighting plants, the task of materially increasing the use of electricity for lighting cannot be called an easy one.

Under such conditions the Muncie Electric Light Company has during the past year obtained an income per capita increase of 40 per cent.; connected lighting demand increase, arc lamps, 4 per cent.; incandescents, 23 per cent., and an enviable broadening of the peak of the lighting-load curve.

Much of this improvement is a direct result of the use of tantalum lamps, their application being widespread, included among its users being nearly all of the prominent stores, hotels, churches, theaters, and numerous residences.

Mr. Fred Leslie, the present aggressive manager of the Muncie Electric Light Company, talks enthusiastically of the merits of the tantalum lamp and its aid in obtaining and retaining business which otherwise would have been lost to gas or gasoline. He relates many instances of customers voluntarily increasing the amount of money they were willing to spend on lighting, due

to their adoption of the tantalum lamp and obtaining a whiter, a more brilliant and a steadier light. An ample tribute to their appreciation of the worth of the tantalum lamp is the 10,000 tantalum lamps now in use out of a total of 32,000 16-c.p. lamp equivalents connected. This appreciation is further attested by the fact that each lamp was sold at 60 cents, and that few converts again returned to the old carbon-filament lamp, which they could obtain at about 15 cents.

There are two methods of charging employed by the Muncie Electric Light Company, one, a straight meter rate, sliding from 10 cents to 5 cents per kw.-hour, according to the total energy used, the low rate being given on all bills showing over 1,000 kw.-hours' use per month; the other, a flat rate of 60 cents a month for each 16-c.p. lamp connected (or lamp of equivalent wattage). On the meter rate, a customer increases his cost for lamp renewals and with a total increased cost, including renewals and energy charge, of from 10 per cent. to 20 per cent. (depending upon rate), he obtains continuously 60 per cent. more light. On the flat-rate basis he gets this additional 60 per cent. more light at a lower proportionate cost, varying with his average daily hourse use of light. His total cost for lighting on an average daily use of two hours is increased by 2½ per cent.; four hours, 5 per cent.; eight hours, 10 per cent., etc.

It will be noticed that with the longer daily hours' use, although the cost for energy to a consumer on a flat rate is constant, his increased cost for lamp renewals on a lamp like the tantalum is sufficient to prevent a wilful waste of energy.

About one-half of the tantalum lamps installed are used on the flat-rate charge, under a two years' contract, the company in this case agreeing to furnish the customer with fixtures, sockets and porcelain shades.

It will be seen that the rate of 60 cents per month for each 50 watts connected produces $144 per annum per kilowatt connected, a lucrative return to the central station. This rate is attractive to the consumer only in connection with the tantalum lamp, giving 25 candle-power for 50 watts, instead of 16 candle-power, at simply the increased cost for lamps, which averages less than five cents a month for each outlet. Most of the stores have adapted their distribution of fixtures and sockets to the use of the tantalum lamp, thereby reducing the number of outlets and in that way deriving all the benefit of the superior efficiency of the new lamp.

Mr. George W. Tidd, formerly manager of the Muncie Electric Light Company, and now continuing his work with the American Gas & Electric properties, is a practical, hustling central-station man. He early saw the possibilities of the newer metallic-filament lamps, and while other companies were debating whether specific consumption of 2.8 w. p. c. or 2.5 w. p. c. should be adopted, Mr. Todd reached out and secured the most efficient lamp available, and the result is to-day that Muncie is the best electrically lighted city in the Middle West. It is best from the consumer's point of view, because he is obtaining an abundance of light of a beautiful, brilliant white quality, and best from the central-station man's standpoint, as he is obtaining more and more business on the basis of $144 per year per kilowatt.

Foreign Items

Compiled by J. S. Dow.

Dr. Monasch (*Jour. für Gasbeleuchtung*, Dec. 21, 1907), discusses the various methods of denoting the unit of intensity of illumination in various countries and advocates the general adoption of some recognized international term, such as the "lux." He states further that such a term ought not to be an attempt at definition such as is presented by the terms "candle-foot" and "candle-meter," etc. The multipation of terms of this nature, containing varying units of length and candle-power according to the taste of each particular country is regrettable, for it adds to the difficulties in the way of those who study the results obtained in different countries and leads to much confusion.

Some recent correspondence in this country has referred to the question which is the best method of specifying the minimum street illumination, and in particular whether the illumination should be measured on a horizontal plane. It may be urged that we are not concerned solely with such horizontal illumination. We, for instance, recognize the face of a friend by means of rays which would be ignored by horizontal measurements. Yet there are difficulties in the photometry of both methods and it may also be said that measurements in any other than a horizontal plane may fail to take account of the illumination from all the possible sources of light. This view is taken by Mr. Roger T. Smith, who, in a recent letter, advocates the measurement on the basis of horizontal illumination, the photometer being placed four feet above the ground.

Attention has also been lately directed to the question of school illumination by the publication of the report of Dr. Kerr, medical officer to the London County Council, and the importance of this special aspect of illumination deserves general recognition. Dr. Kerr advocates an even diffused illumination of not less than one candle-foot for reading purposes and he also insists upon the necessity for treating the teacher's and scholar's portions of the room in detail. We want not only to provide adequate reading illumination for the latter but also to make provision for the teacher's needs and to undertake the suitable illumination of diagrams, blackboards, etc.

C. A. Baker (*Elec. Rev.*, Jan. 17), criticizes the illumination of Westminster Abbey, which he regards as not only quite inadequate from the point of view of the congregation, but also as not coming up to the standard of aesthetic requirements which the illumination of such a building demands.

PHOTOMETRY.

The *Elektrotechnische Zeitschrift* for January 2, contains an interesting description of the photometrical laboratory of an arc lamp factory at Leipsic. The laboratories are very completely equipped for the measurement of high candle power and the taking of polar curves of distribution of light in an exceptionally complete manner, and the illustrations show the use of the Ulbricht globe for obtaining values of M.S.C.P. of arc lamps, etc. The globe shown in the illustration is no less than 3 meters in diameter and it is a little surprising that such globes, which seem to be now regarded as thoroughly practical and serviceable bits of apparatus in Germany, have not found their way into any but very casual use over here. Some of the photometry rooms are blackened in the usual way but others are devoted to the special purposes of studying the effect of various wall-papers, etc. There is also a room where special measurements are made of the color values of the sources tested, and a spectro-photometer is installed and used for the purpose.

Krüss (*Jour. für Gas.*, etc., Dec. 28, 1907), describes some experiments, the main object of which was to obtain the distribution of light from the Hefner lamp and the relation between its horizontal and mean spherical C.P. The distribution of light from such a source as the incandescent mantle can be calculated theoretically with very fair exactitude, but that of flames, owing to their transparent nature, cannot. Krüss finds that the C.P of the Hefner flame, for example, falls off less rapidly on either side of the maximum value than theoretical calculation would suggest. He gives the M.S.C.P. as 0.89, the mean upper hemispherical C.P. as 0.94, and the mean lower hemispherical C.P. as 0.83.

Voege (*E. T. Z.*, Jan. 16, 1908), explains his method of applying the thermopile to the measurement of the distribution of light from a source of light. He points out that the obtaining of polar in the usual way is very laborious, and in the case of a fluctuating source such as the arc light, not very accurate either. He states further that a sensitive thermopile, in spite of the fact that it measures energy and not light, may be used for the determination of the polar curves of such sources as the glow lamp, each portion of the filament of which radiates energy of the same character and shows some curves of the tantalum and other lamps thus obtained. The application of the method to such sources as arc lamps is less evident, because in this case part of the light comes from the carbons and part from the incandescent vapor and it is uncertain whether the radiation from both would be of the same nature.

The author, however, claims to have minimized this difficulty by causing the light falling upon the thermopile to first pass through a thickness of clear glass and also a layer of green glass which very largely absorbs the heat rays. He also arranges a reflecting galvanometer to throw

a beam upon a suitable photographic screen, so that a record can be obtained of the variation of a source of light.

It is possible that the so-called mechanical measurements of light might often be very profitably used for comparative results, but, one would suppose, only for the purpose of comparing lights of exactly the same nature, and with a very clear perception of the limitations of the method. There seems no reason why the method referred to above should not yield fairly satisfactory results, and the curves shown by the author certainly resemble these generally characteristic of the sources they represent. One would have preferred, however, the author to have shown curves obtained by his own plan side by side with those arrived by the usual photometric method, and this he does not seem to have done.

Tufts (*Phys. Rev.*, Dec., 1907), investigates the curve of spectral luminosity of various observers, some color-blind and others normal. On the whole his results seem to be somewhat inconclusive. He finds, for instance, that the color-blindness *may* influence the sensation of luminosity of an observer, but not necessarily so. In some cases a color-blind observer would, therefore, obtain peculiar photometrical readings, but failure to distinguish colors satisfactorily does not necessarily mean that this will be the case. He also investigates the effect of prolonged exposure to light of one particular color, and, contrary to the results of other observers, finds that the spectral curve of luminosity is not much affected thereby, except in the case of red light. Finally, he considers that his experiments, on the whole, support the contention that a distinct sense of *light* as distinguished from color, exists, though the fact that it is apparently possible to disturb the one without disturbing the other is against this view.

The *Gas World* and the *Journal of Gaslighting* contain further abstracts of the report of the American Gas Institute previously mentioned.

In the most recent bulletin of the Société Internationale des Electriciens, M. Laporte gives a résumé of the decisions of the International Commission on Photometry, and also particulars of the exact recognized dimensions of the standard Carcel lamp.

ELECTRIC LIGHTING.

A technical discussion of the chemical and physical aspect of the process of graphitizing filaments is to be found in the *Zeitschrift für Beleuchtungswesen* for Jan. 10. Dr. Lux has recently expressed the view that we may eventually return to the carbon filament as the ultimate solution of the high efficiency and durable incandescent lamp. Therefore, any light that can be shed the exact nature of the constituents of the filament which make for durability are of interest. It would appear that the chief point to be gained by special treatments of the carbon filament is the rendering of the pores in the material as small as possible. By so doing the influence of the escaping gases from the filament and their presumable deteriorating effect, are reduced to a minimum.

Bohm has also compiled an exhaustive and useful résumé of recent patents on the subject of the metallic filament lamps.

Several recent articles on the subject of arc-lighting have recently appeared. Attention may be drawn to the paper on the subject by Dr. Blondel (*Bull. Soc. Int. des Electriciens*, March, 1907). The author prefaced his main subject by a discussion of the chief phenomena of radiation referring to the well-known work of Lummer and Pringsheim on the radiation of the black body. Afterwards he deals fully with the different methods of preparing the newer types of arc light carbons and gives a number of curves illustrating the connection between arc-length and P.D., etc.

Krause and Dyott deal with arc-lighting in general and the magnetic arc respectively.

GASLIGHTING, ETC.

Mr. F. W. Goodenough, in a recent lecture on shoplighting drew attention to the merits of gas for this purpose and incidentally emphasized several simple but vital points in shoplighting. He drew attention to the wisdom of so placing the lights used to illuminate the goods in the windows as not to dazzle the eyes of the customer and recommended the use of sources, surrounded by suitable diffusing globes, placed high up so as to throw the light downwards on the goods. He also gave some simple rules for general lighting, on the basis of so many C.P. per cubic foot of contents of shop, and per foot run of shop frontage. Finally he impressed upon his hearers the necessity for attending to the maintenance of burners, etc., and allowing them plenty of pressure, and mentioned some cases in which gas had

been installed with very satisfactory economical results.

Mr. H. Butterfield (*reported Jour of Gaslighting*, Jan. 17), described an installation which had been converted from low to high pressure on the Keith system, with satisfactory results.

Wedler (*Jour. für Gas.*, etc., Dec. 17, 1907), gives some details of the application of incandescent mantles to train lighting. The great difficulty in the way of the general application of incandescent mantles to this purpose has hitherto been the fragility of the mantles, but now that their strength has been very much improved, they are finding more application. Inverted burners are specially suited for carriage illumination in one respect, namely, owing to the fact that no shadow is thrown by them as is the case with the upright type. On the other hand they have a tendency to break and fall from their holders in time and when this happens the passenger may be left without any light. To guard against this contingency, an Austrian Company provides a cock which in an emergency can be turned on so as to provide a second light. On one of the French railways a mantle only lasts 17 days, but it must be added that these mantles are in use for 18 hours each day. On the Prussian lines a mantle usually lasts 50 to 60 days.

G. Dettman (*Jour. für Gas.*, etc., Dec. 7, 1907), winds up a very prolonged controversy with F. Schafer on the relative safety of gas and electricity for illumination. As is not infrequent in such cases neither of the disputants seems to have been convinced by the flood of statistics, but probably the ventilation of the mat has been instructive to those looking on.

Acetylene for January, contains some interesting notes on the value of acetylene for lighthouses, buoys, etc. In this connection the report of Captain Ross of the U. S. Navy, is quoted. Acetylene for buoys, etc., claims the advantages that more light can be obtained from the same volume of gas, that it is more powerful, especially owing to the fact that relatively little pressure is needed, and that when over 10 atmospheres pressure is used for the compression of gas the heavier hydrocarbons begin to condense as oil, and the richness of the gas from an illuminating point of view is diminished thereby. Some attention is also given to the use of acetylene, chiefly in France, with incandescent mantles. A difficulty which some appear to find at present is that the adjustment of the burners, which have to be specially constructed, is rather too delicate for the average householder to handle.

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BY C. RICHARD BOEHM.

From Chemiker Zeitung.

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7. Compt. Rend, 1900, V. 131, p. 837, 891; Chem. Zeit., 1901, V. 24, p. 1062.

8. Compt. Rend., 1900, V. 131, p. 595, 865.

9. Later Matterman and Kraft (Lieb. Ann. Chem., 1902, V. 325, p. 263-278. Karl Kraft Dissertation, Polytechnicum, Muenchen (1903, p. 9-34), also the latter in collaboration with F. Kellenberger (Lieb. Ann. Chem., 1902, V. 325, p. 279-281), further Matterman and E. Bauer (Tech. Ann. Chem., 1902, V. 325, p. 281-291), also the Beck (Dissertation, Polytechnicum, Muenchen, 1906, approved 1907, p. 54 to 59), worked on the hydrogen compounds and nitrogenous compounds of the rare earths. M. V. Bolton points out in his German patent 169,928 (Vl. 21) of July 30th, 1904, issued April 21, 1906, that these compounds are dissociated at the high temperature of the arc. This is the reason why he wants to use the nitrogen compounds of rare earths (respectively the combinations of the elements of the fifth group of the periodic-system) as materials for glowing bodies (154,299 of March 20, 1901), issued Sept. 7th, 1904, Siemens & Halske. He also proposes the use of nibium, vanadium and tantalum (German patent 15,857a d (Vl. 21) of April 3, 1902, issued February 12th, 1905, supplement to 154,527, Siemens & Halske). The applicant of the Sanders patents was very much mistaken in his supposition that the nitrogen and hydrogen compound of the rare earths are luminous in his glowing bodies. The nitrogen compounds of boron and silicon were frequently used as raw material for glowing bodies, for instance in the German patent 120,875 (Vl. 21) of February 20, 1900, issued May 23, 1901, A. Jaff; 132,713 (Vl. 21) of September 28, 1901, issued June 23, 1902, supplement to 120,875 for electrolyte bodies. According to Nernst F. Kushenitz uses nitrogen boron compound (German patent 185,496 (Vol. 21) of June 16th, 1905, issued April 22, 1907).

10. A mixture of nitrogen and hydrogen may be used with advantage as its heat conductivity is inferior to that of pure hydrogen. A lamp with four metallic filaments requires for its formation about 21 lbs. of this gas mixture, which is important in the calculation of the manufacture. This is the reason why it was recently tried to find a cheaper substitute for this mixture of gases (the application for letters patent of the G. E. Co. A. 13,561 (Vl. 21) of September 6, 1906, published July 8, 1907). According to the English patent 18,814 (1905) the carbon containing tungsten filaments are freed of the carbon in an atmosphere of hydrogen containing oxygen, while the German Gasgluecht Gesellschaft (German patent 182,683 (Vl. 21) of January 18th, 1905, issued February 11, 1907), prescribes the presence of steam. The injurious influence of moisture on the filaments can be seen from the following applications for letters patent W. 26,588 (Vl. 21) of October 31, 1906; published July 11, 1907, wilfram (tungsten) lamps, A. G. Augsburg; D. 17,285 (Vl. 21) on July 11, 1906, published July 11, 1907, German Gasgluelicht Ges. The density of the gas also plays a part in the formation of the filament. (Tungsten lamps, A. G. Augsburg, German patent 184,379 (Vl. 21) of June 9, 1905, issued March 25, 1907). When the filaments are shaped in an indifferent (neutral) atmosphere, they have a tendency to get distorted in the rotating or alternating current. Even in a direct current the filament gets twisted in a certain direction, caused by the influence of the magnetic field. In consequence of this the German Gasgluelicht Gesellschaft were compelled to use complicated apparatus in order to avoid this inconvenient effect. (German patent 188,228 (Vl. 21) of October 29th, 1905, issued July 10th, 1907). The incandescent lamp works of Anker G. m. b. H. makes propositions in the direction. (Application for letters patent G. 24,843 (Vl. 21) of June 15th, 1907; published June 27, 1907). The filaments are placed in series during the process of shaping. (Tungsten lamps A. G. Augsburg, German patent 185,906 (Vl. 21) of February 13, 1906, issued April 29, 1907).

11. German patent 140,323 of May 16, 1901, issued March 26, 1903, the use of gaseous hydrogen compounds of the rare earths, supplement to 133,701; 141,353 of April 20, 1901, issued April 28, 1903, use of gaseous nitrogen compounds of the rare earths, etc., supplements to 137,569 and 148,257, of May 4, 1901, issued June 20 ,1904, process for the formation of a metallic conductor enclosing poor conductors or conductors of the second class.

12. The surrounding of metal or carbon cores with metallic shells is not new by any means. For instance, Geminiano Zanni recommended as early as 1882 to precipitate platinum or iridium electrolytically on a carbon filament. (German patent 24,370 (Vl. 21) of December 31, 1882, issued October 4, 1883.) As atmospheres were proposed to use volatile silicium and boron compounds in order to aggregate electrically boron or silicon on a carbon or metal core. (Rud. Longhans, German patent 53,585 (Vl. 21) of February 18th, 1890, issued August, 1890.) A similar patent was taken for Siemens & Halske by M. Rotter (German patent 56,226 (Vl. 21) of July 3, 1890, issued March 12, 1891), further by I. Clegg (German patent 64,678 (Vl. 21) of November 4th, 1890, issued September 27, 1892). The German patent 59,172 (Vl. 21) of July 3, 1890, issued October 21, 1891, to M. Rotten for Siemens & Halske reached the climax of chemical absurdity. It recommends namely the use of an atmospheric metallic phosphites and metallic phosphite carburettes (carbides). For the same purpose I. R. Crawford recommended the use of silicon tetzaaphenyl and Si. and B. triaetylphenyl (German patent 178,474 (Vl. 21) of August 4, 1905, issued October 15th, 1906). Finally the process proposed by W. L. Voelkerand, consisting in transforming carbon into carbide filaments by subjecting them and the arc to the influence of metallic vapors (German paetnt 130,020 (Vl. 21) of July 18th, 1900, issued April 5th, 1902).

13. I. S. Wilcox Aldridge (German patent 36,-788 (Vl. 21) of Jan. 18th, 1885, issued August 11th, 1886; S. B. Tibbetts S. p. 53,871 (Vl. 21) of July 30th, 1889, issued Oct. 11th, 1890; La Lumiere Electrique, 1889, V. 34, p. 379; Alex. Lodygine, Amer, Pat. 575,002 of Jan. 12th, 1897, announced was the patent already in Jan. 4th, 1893, Series 457,227.

14. German patent 174,221 (Vl. 21) of April 14th, 1905, issued July 11th, 1906.

15. See Chem. Ztg., 1906, p 730, my article concerning new electric incandescent lamps; further Zeitsch. f. Beleucht., 1907, p. 107.

16. Poggendorp Ann., 1824, V. 4, p. 117.

17. See A. Schmidt, Dissertation Tuebingen, 1891, p. 41-42.

18. In order to make glowing bodies out of a combination of conductors of the first and second class it is necessary to mix the raw material intimately. R. E. Menges (German patent 134,756 (Vl. 21) Oct. 28th. 1898, issued Feb. 25th, 1902), for instance precipitates the united solutions of the rare earths with sodium hydrate. As known from experience it is just in the manufacture of filaments from tungsten where the most difficulties are met with, especially in the process of pulverizing, as there are always some ductile metallic oxides. For this reason it is impossible to prepare filaments of a mixture of metallic tantalum with conductors of the second class. It is therefore being attempted to obviate the difficulty by reduction of a mixture of an oxide of tantalum with a conductor of the second class (Siemens & Halske German patent 161,081 (Vl. 21) of Nov. 29th, 1903, issued May 30th, 1905, zirconium earths mixed with a conductive lower oxide of tantalum). However the great affinity of tantalum for hydrogen (Heck v. Vironi, Zeit. Elect., 1904, V. 11, p. 558-560) causes enormous difficulties in the process of shaping and these difficulties have proved so far practically unsurmountable. It is rather peculiar that tungsten does not show any affinity for hydrogen, so that it is comparatively easy to prepare mixtures of reducible tungsten compounds with conductors of the second class and to reduce them at a high temperature in current of hydrogen. In this way is being made a conglomeration of tungsten in the finest subdivision (Consortium for Electrochemical Industry G. m. b. H. Nuerenberg and Dr. W. Nernst, German patent 178,475 (Vl. 21) of Sept. 10, 1905, issued October 15th, 1906). This process was supplemented by fluxing together of the component parts in an iridium crucible with the aid of an oxyhydrogen flame. Thorium earth and zirconium earth combine here with tungstic acid according to the following equations: Tho2 plus 2 Wo2 equals Thw2O3; ZRO2 plus 2 WO2 equals Z2W2O3. These wolframates were not known till lately and represent bodies of greenish color and high melting points. By heating in an atmosphere of hydrogen tungsten metal is produced, the color changing from pale green to dark blue, brown and dark, while the thorium earth and zirconium earth remains unchanged and in finer subdivision. Molybdenum behaves as tungsten (Consortium for Chem. Ind. Gmb. H. Nuerenberg German patent 184,704, Feb. 15th, 1906, issued April 25th, 1907, supplement to 178,475).

* Paper read at the gathering of the 79th Session of the German Natural Scientists and Physicians, Dresden.

19. Corresponding metallic additions of either metals of high melting points, of which is composed the carbide of the filament or metals, which are distilled over at the high temperature used in the process of shaping. E. Sander for the Electrodon Soc., now Dr. Hollefreund & Co., Berlin, German patent 140,378 (Vl. 21) of August, 1900, issued March 25th, 1903; same 146,555 (Vl. 21) of Dec. 30th, 1900, issued Nov. 11, 1903, supplement to 140,378, shaping of the filament, *i. e.*, formation of the carbide in the filament by electric heating in an atmosphere of hydrogen, resp. carbon-hydrogen atmosphere. Compare also Fr. Damere German patent 111,900 (Vl. 21) of Jan. 10th, 1899, issued May 28th, 1900; same German patent 129,687 (Vl. 21) of May 3rd, 1900, issued March 12th, 1902, supplement to 111,899; Siemens and Halske, German patent 158,571 (Vl. 21) of May 3rd, 1902, issued Feb. 21st, 1905, supplement to 154,527, additions of the oxides of metals of thoriums, zirconium and Yttrium elements to the carbides of Vd, Nb and Ta. See also J. Lux German patent 188,509 (Vl. 21) of Sept. 12th, 1905, issued July 8th, 1907, addition of magnesium or aluminum to the filament.

20. German patent 140,088 (Vl. 21) of May 16th, 1901, issued March 12th, 1903, 140,837 (Vl. 21) of June 21, 1901, issued April 2d, 1903, supplement to 140,088, Siemens and Halske.

21. W. L. Voelker used the carbide of zorconium as the carbides of other rare earths (German patent 130.709 (Vl. 21) of July 18th, 1900, issued May 1st, 1902) in incandescent filaments. Siemens and Halske choose to use the nitrogen compound, viz., the compound of the group V of the period is the system of elements with Zr, Th, and the elements of the Yttrium group (German patent 154,299 (Vl. 21) of March 20th, 1901, issued Sept, 7th, 1904). These earths were also used as additions to the carbides of Vd, Mb and Ta (Th, Zr, Yttrium earths) (Siemens and Halske German patent 153,352 (Vl. 21) of May 3d, 1902, issued July 23d, 1904; same 118,571 (Vl. 21) of May 3d, 1902, issued Feb. 21st, 1905). The Austrian Gasgluelicht and Electr. Soc. added the stme earths .Tho2 Z202 and Ytter earths) to this osmiun paste (German patent 140,468 (Vl. 21) of Sept. 24th, 1898, issued March 26th, 1903, supplement to 138,135). Wilh. Buchner surrounded a carbon core with the oxides of silicates of Zr, Ca, Al and Be (German patent 254,448 (Vl. 21) of April 19th, 1882, issued February 5th, 1884) while Gans preferred a core of platinum and covered it with the aid of lavender oil with an emulsion of the oxides Zr, Th, Ce, La, Di and E2 (Pharm. Zeit. of Lud.). Wihl. Gans German patent 108,-506 (Vl. 21) of August 3d, 1898, issued January 8th, 1900. In this core as in many others a mixture of carbon (from the organic binder) and oxides or metals, resp. where a carbon core is used also—is used, the glowing process transforms the compounds into respective carbides. The glowing bodies of A. Just and Rob. Falk (German patent 128925), Vl. 21, of Dec. 6th, 1900, issued Feb. 15th, 1902), will therefore be a carbidic glowing body, as without an organic binder it is impossible to incorporate a molecular mixture of metallic zirconium (if such is at all available) and zirconium earth in a fine filament. The experience of Kellner with his glowing body composed of thorium metal (so far nobody has produced thorium metal in a pure state) or oxide of thorium (German patent 138468 (Vl. 21), of Sept. 17th, 1898, issued Jan. 30th, 1903, Piezen. fur Kellner), was here regulated. Even with the application of the highest pressure only more or less thickness may be attained if the organic binder be eliminated.

22. Alex. Just (German patent 120875 (Vl. 21), of Feb. 20th, 1900, issued May 23d, 1901; 132713 (Vl. 21) of Sept. 28th, 1901, issued June 23d, 1902, supplement to 120875), and F. Kuschenitz (German patent 185496 (Vl. 21) of June 16th, 1905, issued April 29th, 1907), called attention to the fact that the nitrides of boron and silicon are not disassociated even at high temperatures. The nitrogen vanishes only when the current is passed through the filament in the vacuum.

23. The spotting of filaments is explainable by the oxidation and vaporization of the oxide at the high temperature of the glowing filament. The diameter of the filament in the respective spot diminishes, the resistance increases and with it the heat causes a burning through.

24. German patent 120872 (Vl. 21) of Feb. 20th, 1900, issued May 23d, 1901.

25. German patent 132713 (Vl. 21) of Sept. 28th, 1901, issued June 23d, 1907. Supplement to 120875.

26. German patent 115708 (Vl. 21) of Sept. 3d, 1899, issued Nov. 15th, 1900.

27. German patent 129488 (Vl. 21) of Sept. 26th, 1899, issued Feb. 28th, 1907.

28. A. Koch, German patent 123789 (Vl. 21) of March 24th, 1900, issued April 29th, 1901. A. Prediger, German patent 182,077 (Vl. 21) of Dec. 5th, 1905, issued Jan. 23d, 1907.

29. R. Langhans, German patent 53585 (Vl. 21) of Feb. 18th, 1890, issued Aug. 27th, 1890. M. M. Rotten for Siemens Halske, German patent 5626 (Vl. 21) of July 3d, 1890, issued March 12th, 1891.

30. S. R. Crawford, German patent 178474 (Vl. 21) of Aug. 4th, 1905, issued Oct. 15th, 1906.

31. Haefner and Langhans, German patent 44183 (Vl. 21) of Nov. 9th, 1887, issued July 17th, 1888.

32. German patent 184706 (Vl. 21) of April 27th, 1906, issued April 2d, 1907.

33. Concerning the composition of the commercial amorphous boron s. N. A. Orlow, Chemiker Ztg., 1902, p. 465.

34. German patent 135759, of Feb. 8th, 1901, issued Oct. 27th, 1902, carbides of bond Si; 137044 (Vl. 21) of Oct. 31, 1901, issued Nov. 29th, 1902. supplement to 135759.

35. German patent 109864 (Vl. 21) of March 18th, 1898, issued Feb. 23d, 1900; 11481, of March 5th, 1899, issued May 11th, 1900, supplement to 109864.

36. Siemens & Halske, German patent 154299, of March 28th, 1901, issued Sept. 7th, 1904.

37. Siemens & Halske, German patent 153352 (Vl. 21) of May 3, 1902, issued Feb. 21, 1905, supplement to 154527.

38. Austrian Gasgluehlicht und Elect. Ges, G. patent 140468 (Vl. 21) of Sept. 24, 1898, issued March 26th, 1903, supplement to 138135.

39. G. patent 162705 (Vl. 21) April 11th, 1899, issued Oct. 10, 1905, supplement to 138135.

40. German patent 140503 (Vl. 21) of Nov. 29th, 1900, issued March 30, 1903.

41. See Pieper for Kellner, Vienna, G. patent 138468 (Vl. 21) Sept. 17th. 1898, issued Jan. 30th, 1903. An interference with Siemens & Halske delayed the issue of the patent.

42. G. patent 172189 (Vl. 21) of May 5th, 1905, issued June 21st, 1906.

43. G. patent 158571 (Vl. 21) of May 3d, 1902, issued Feb. 21, 1905, supplement to 154527, Siemens & Halske, same 158570 (Vl. 21) of April 3, 1902, issued Feb. 17th, 1905.

44. G. patent 134576 (Vl. 21), Oct. 28th, issued Sept. 25th, 1902.

45. V. Bolton resp. Siemens & Halske, G. patent 165057 (Vl. 21), Oct. 14, 1904, issued Nov. 24, 1905, supplement to 159811.

46. G. patent 130709 (Vl. 21) of July 18th, 1900, issued May 1, 1902, 111481 (Vl. 21) of March 5th, 1899, issued May 11, 1900, supplement to 109864.

47. G. patent 134756 (Vl. 21), Oct. 28, 1898, issued Sept. 20, 1892.

48. G. patent 162705 (Vl. 21) April 11, 1899, issued Oct. 10, 1903; supplement to 138135.

49. G. patent 161081 (Vl. 21), Nov. 29, 1903, issued May 3, 1905.

50. Application A 13543 (Vl. 21), Aug. 21, 1906, published June 27, 1907.

51. G. patent 178465 (Vl. 21), Dec. 6, 1904, issued Oct. 15, 1906; A. E. G. resp., General Electric Co.

52. G. patent 180452 (Vl. 21), Jan. 6, 1904, issued Dec. 17, 1906; Zeitschrift Beleuchtungsw. 1905, V. 26, 1907, page 135.

53. G. patent 178472 (Vl. 21), Nov. 18, 1904, issued Oct. 15, 1906.

54. G. patent 176447 (Vl. 21), Oct. 24, 1903, issued Sept. 25, 1906, G. El. Co.

55. G. patent 184706 (Vl. 21), April 27, 1906, issued April 2, 1907.

56. G. patent 169928 (Vl. 21), July 3, 1904, issued April 21, 1906.

57. Pieper for Kellner G. patent 138468 (Vl. 21), Sept. 17, 1898, issued Jan. 30, 1903.

58. G. patent 130709 (Vl. 21), July 28, 1900, issued May 1, 1902; 109864 (Vl. 21) March 18, 1898, issued Feb. 23, 1900; 111481 (Vl. 21), March 5, 1899, issued May 22, 1900.

59. G. patent 134756 (Vl. 21) Oct. 28, 1898, issued Sept. 25, 1902.

60. G. patent 36788 (Vl. 21), Jan. 18, 1885, issued Aug. 11, 1886; A. S. Wilcox Aldridge.

61. G. patent 109864 (Vl. 21), March 18, 1898, issued Feb. 23, 1900; supplement to 111481; Jas. Clegg. G. patent 64678 (Vl. 21), Nov. 4, 1890, issued Sept. 27, 1892.

62. G. patent 38926 (Vl. 21), July 28, 1886, issued March 1, 1887; supplement to 49206 (Vl. 21), Jan. 25, 1889, issued Sept. 28, 1889.

63. G. patent 115708 (Vl. 21), Sept. 3, 1899, issued Nov. 15, 1900.

64. G. patent 115709 (Vl. 21), Dec. 9, 1899, issued Nov. 12, 1900.

65. G. patent 120875 (Vl. 21) Feb. 20, 1900, issued May 23, 1901; Alex Jaff, G. patent 132713 (Vl. 21), Sept. 28, 1901, issued June 23, 1902; supplement to 120, 875 same.

66. G. patent 129488 (Vl. 21), Sept. 28, 1899, issued Feb. 28, 1902.

67. G. patent 53585 (Vl. 21), Feb. 18, 1890, issued Aug. 27, 1890.

68. Application of the M. Rotten G. patent 56226 (Vl. 21), July 3, 1890, issued March 12, 1891.

69. G. patent 178474 (Vl. 21) Aug. 20, 1905, issued Oct. 15, 1906, tetrophenyl and triaelylsilicon.

70. See, for instance, Haefner and Langhous G. patent 44183 (Vl. 21), Nov. 9, 1887, issued July 12, 1888, core made of uranates, titanates and molysdates of Zr, Th, Ce, Li, Di, Er, Tl, Y Gallium, alkaline earths, chg. Al, Be, Shakelton, Hallet, G. patent 22687 (Vl. 21), March 30, 1882, issued June 13, 1883; core cylinder filled with, or encased in silicon, containing graphite, Leon de Lomzée, G. patent 115279 (Vl. 21), Dec. 8, 1899, issued Nov. 21, 1900, care of conductors of second class, surface Pt. or Si.

71. G. patent 162705 (Vl. 21), April 11, 1899, issued Oct. 10, 1903; supplement to 138135.

72. G. patent 25448 (Vl. 21), Sept. 19, 1882, issued Feb. 5, 1884.

73. The Weber H. Carbon filament, etc., Hanover, 1907, p. 21; the G. patents 13611 of May 12, 1892, is mentioned; the patent could not be found; therefore, I assume misprints and mistakes in the number of the patent.

74. G. patent 176001 (Vl. 21), 1905, issued Sept. 3, 1906, published in the Reihsanzeiger, May 25, 1906, No. 20502, Vl. 21.

75. S. 24464, April 18, 1907, published June 27, 1907, supplement to 176001.

76. German patent 171309 (Vl. 21), Jan. 20, 1905, issued June 2, 1906. Zeitsch. Beleucht. Heft. 5th, Feb. 20, 1907, pp. 49-50.

77. German patent 137576 (Vl. 21), Dec. 6, 1899; 143302 (Vl. 21), Jan. 21, 1900, issued July 18, 1903, ——— to 137576; 144968 (Vl. 21), Aug. 25, 1900, issued Oct. 20, 1903,—to 137576.

78. German patent 109069 (Vl. 21), April 5, 1899, issued Feb. 5, 1900.

79. German patent 24370 (Vl. 21), Dec. 21, 1882, issued Oct. 21, 1883.

80. German patent 25448 (Vl. 21), Sept. 29, 1882, issued Feb. 5, 1889.

81. German patent 38926 (Vl. 21), July 28, 1886, issued March 1, 1887; supplement to it 49206 (Vl. 21), Jan. 25, 1889, issued Sept. 28, 1906; 170404 (Vl. 21), Aug. 21, 1904, issued May 10, 1906.

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